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VITAMINS IN THE FUTURE[1]

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AMONG the dusty reprints which I treasure is a yellow-backed one from the *Journal of Physiology* bearing the date of December, 1911, in which Casimir Funk first proposed the name "vitamine." As I had at that time been working with Vedder for more than a year on "the beriberi-preventing substance," I may, in a sense, claim to have been one of the midwives in attendance at that historic birth. Vedder and I were among the first, if not the first, authors to take up the use of the term in our first joint paper, published somewhat belatedly in 1913. In 1916 my testimony in refutation of the claims of the manufacturer of a cure-all was part of the first court record in which the term appeared. As the years have overtaken my plodding feet, the number of scientific papers which employ the word "vitamin" has grown from a paltry two or three to some thousands annually.

I have recently been reading some medical biographies and particularly Clapesattle's story of the Mayos. There one notes that, although Pasteur indicted the atmosphere as a source of infective organisms in 1864, although Lister announced his method of antiseptic surgery in 1867 and had achieved international acclaim for his work by 1879, Will Mayo appears to have graduated in medicine at Michigan in 1883 with only a superficial knowledge of Listerism and scant conviction of its merits. It was not till

[1] Address on the occasion of the presentation of the Charles Frederick Chandler Medal of Columbia University, February 26, 1942.

four years later that he became a thorough convert, as were the majority of new medical graduates from that time onward. It had taken nearly twenty years for Listerism to gather momentum, but it then revolutionized surgery in a decade. It made deep surgery, especially abdominal surgery, possible. We are now in the midst of a like development of what may be called vitaminism, a development which is the more conspicuous because much of its content is appropriate to the use of the layman as well as the physician. The progress of its application has likewise been slow till recently but is now greatly accelerated.

May I ask you to consider with me some of those more immediate applications of vitaminism which we can discern are already beginning but which will require many years for full realization. It will be appropriate if I leave to my fellow medalist the role of longer range prophecy, for he will presumably live longer to enjoy the later triumphs of vitaminism, as well as to regret his prophetic errors if he should make such.

There are six vitamins which have already acquired an importance for the workaday world, for the layman, for the food technologist and for the practicing physician. By their lack ye shall know them. Five of the six are commemorated in the existence of ancient and wide-spread diseases which are known by household names in all the principal tongues of the earth. Perhaps the oldest of these diseases is beriberi, due primarily to a lack of thiamin. The earliest supposed reference to the malady is attributed to Hwangti, who adorned the medical profession about 2700 B.C. Scurvy ranks next in antiquity, for it was recognizably described by Hippocrates, the father of western medicine, about 400 B.C. and was the scourge of medieval armies and of the seamen of the age of exploration. The Englishman, long famed as a sailor, is still called a lime-juicer for his judicious use of this source of vitamin C. Rickets once had an association with England also. It was called the English disease because it was first described in 1650 by the Englishman Glisson, though it probably occurred earlier, as has been inferred from the rachitic appearance of children in German paintings of the fifteenth and sixteenth centuries. The virtue of cod liver oil in its treatment we now ascribe to vitamin D.

Pellagra seems definitely a product of the New World and has had an intimate association with maize, the New World cereal. Pellagra was noted first in American Indians about 1600 and almost simultaneously in Italian peasants who used maize as food. For a year or two now we have known that among the cereals maize is conspicuously low in nicotinic acid, only recently recognized as the anti-pellagra vitamin.

Lack of vitamin A is widely associated with a dryness of the eyes and also with night blindness occurring in many lands. The latter has been recognized in such widely separated areas as India, Japan and Newfoundland. It has occurred among Australian cattle. It has, however, belonged primarily to popular lore rather than to official medicine, which long hesitated to rate it as a definite entity. In Ebers' papyrus about 1500 B.C. is the statement, "Because the unknown disease was cured by the roast liver of an ox, the disease was supposed to be night blindness."

Only one of the six vitamins which I have mentioned as important in a workaday sense lacks the monument of a well-defined long-known disease. I refer to riboflavin. The disease due to its absence in the food has no vernacular name and reflects its modernity in the term "ariboflavinosis." Some of its symptoms, notably fissures in the corners of the mouth, have often been noted in association with pellagra with which ariboflavinosis has been confused until within the past three years. Ariboflavinosis causes burning and redness of the eyes and may in extreme cases lead to alterations of the cornea and ultimately blindness. In young rats cataract can readily be induced by this deficiency. In man, however, the symptoms are but rarely severe, though they are frequently encountered among poorly nourished people.

From the fact that five of the six vitamins of present-day practical importance have left their traces in the records of centuries of history, one is tempted to classify the remaining vitamins as lesser ones and even to predict that the vitamins which are yet to be discovered are destined to have a progressively lesser significance for human welfare. At best such a prediction can be true only in the sense that the later vitamins will less frequently be found missing in widely used human dietaries. Even in this sense, exceptions may appear, for there remain well-known but obscure diseases, such as epidemic dropsy and sprue, which seem clearly to have dietary causes. On the whole, however, I think we may say that we have already discovered and produced commercially the vitamins which are required to check the great nutritional plagues of mankind.

Clearly this statement should not be construed to mean that the other vitamins play less essential roles in human physiology. Choline, pyridoxine, pantothenic acid, biotin, inositol, para amino benzoic acid and folic acid may and in most cases probably do perform equally essential functions for the human organism. A gross lack of any one of them might lead to a disturbance as pronounced as that of beriberi or pellagra. But it does seem true that the statistical probability of these lacks in human diets is less, else we should have encountered them historically. The lesser vitamins, if we may call them such

for the sake of brevity, may afford us, however, great revelations regarding physiological and even pathological processes and so must be classified as lesser only in a narrowly defined sense.

My point in distinguishing between the major and the lesser vitamins is not one which primarily concerns the future of research. It is one which concerns present-day technology, present-day economics and present-day sociology. I should like to divert the minds of food processors, teachers of nutrition, practicing physicians and laymen from speculating about the latest surmise of vitamin science and persuade them to devote their major energies to the intelligent application of the vitamins which stand in the front row on the shelf. Since the number of vitamins has multiplied in mystifying confusion, the public taste turns to the newest one as the ladies' eyes turn toward the spring hats. The attraction for the latest novelty hardly surpasses that for gruesome details of symptomatology and pathology. We have popular lectures, even radio programs, on nutrition, which abound in the sordid details of ascites, neuropathies and cirrhoses, all of which is morbid and relatively unprofitable for the layman.

It is high time we should be systematically eradicating the long-known deficiency diseases. What has been done so far in that direction is with few exceptions little and local. Infantile scurvy and rickets have been distinctly diminished among the well-to-do and even the middle classes by increasing use of orange juice and cod liver oil for nursing infants. Happily women increasingly call on the doctor to attend them during confinement and the babies benefit from his advice incidentally at least during their early months. It is socially significant that babies are helpless and can not reject the mother's ministrations. They have accordingly benefited most systematically from nutritional advance. This, however, does not endure long and as the child grows older he is increasingly free to follow the prevalent nutritional abuses of his elders.

There are some aspects of nutrition in which we must continue to rely primarily on the educational process. Good foods must be chosen with reasonable regard to their supplementary relationships. Milk, meats, eggs, green vegetables and fruits need to be used in fair proportion to potatoes, cereals and sugar. Even the careless cookery can seriously mar not only the palatability but also the dietary values of the products. In our present society, care in these particulars must be supplied by the housewife who will continue to need no little instruction, especially if her husband's pocketbook restricts her choices.

We should, however, rely as little as possible upon the uncertain discernment, diligence and discipline of the housewife. Securing good nutrition by volitional choices, especially under economic, geographic and often nationalistic restrictions, often involves an amount of scientific knowledge which can not yet be imparted to the rank and file of working people. When our forebears lived in a state of nature, they got great protection from the fact that they ate things whole, even whole carcasses, and thus got a wide assortment of the chemical substances present in and necessary to all forms of life. Moreover, they had no great staples grown in broad cultivated fields. They pieced out their needs from the intermingled plants of the forest and field and from the animal life that scurried or crawled or swam within the range of their habitat. Diversity was forced upon them. But as husbandry came, there was increasing temptation to subsist largely on that staple food which was produced with the least labor and the greatest assurance. The one-sidedness of these diets was later further aggravated by refining processes applied to the great staples, such as rice, wheat and latterly sugar. Both diversity and wholeness were lost except for the more luxuriously fed segments of mankind.

The first impulsion of our present knowledge of vitamins and their essential roles should be to promote restoration of values lost to the masses by these restrictions. A general removal of economic restraints would largely achieve the result because appetites lead to diversity when income permits. This, however, is a Utopian ideal far beyond our immediate reach. Education, if universal, would largely accomplish the result, for avoidance of refinement is not inherently costly. However, education of the most needy elements is exceedingly slow and difficult. We must, therefore, turn to more effective weapons as soon as education has pervaded the public mind sufficiently to permit their employment.

Legislation is a possible weapon, but considerable public education must precede it. A bill to put a tax on white rice in order to discourage its use was first introduced into the Philippine legislature in 1911. Although it has since been reintroduced several times, it has never succeeded of passage. As a result incapacitation from beriberi is substantially as prevalent as it was thirty years ago, though we have known all that time how it could be prevented. The same condition prevails generally through the rice-eating areas of the Orient. There is apparently nothing prohibitively difficult about handling undermilled rice commercially, for I am told that Cuba prefers its rice in that form and gets nothing else.

Legislation in the United States prohibiting the sale of impoverished white bread and flour is a possibility. Undoubtedly any attempt to prohibit the sale of white wheat products in the United States would meet with insuperable public opposition. However, it is now possible to add artificially the principal

valuable vitamins and minerals of wheat at a cost of something less than twenty-five cents per capita per annum. Increased economic productivity of the bulk of the population would repay the cost perhaps a thousand-fold to say nothing of improved health and sense of well-being. Yet this great reform is being sabotaged or damned with faint praise by half the nutritionists of the country on the ground that it would be still better if we could arrange breakfasts of ham and eggs, whole wheat buns and a glass of milk for everybody. Of course it would, but shall we wait for the millennium to take our first steps to mass repair of our nutritional errors?

Our present pure food legislation does not provide for such regulation of bread and flour. Our food law was aimed at the elimination of poisonous preservatives and the eradication of false statements of quality or identity. It assumed that our traditional and unsophisticated foods were wholesome and does not concern itself directly with their nutritional values. This must presently be changed so that the character of our available staples shall provide automatic protection against gross malnutrition when these staples are consumed in customary proportions and forms.

Pending the day when such legislation can be secured and the necessary scientific methods of control are developed, we must look largely to the food industries for correction of our dietary faults. These industries have been made very conscious of their public obligations, to a great extent through the operation of the pure food laws during recent decades. Within the limits of practicality, they are in general ready to cooperate in such reforms on a voluntary basis. Such an undertaking is the great program for the enrichment of bread and flour which began last May under the auspices of the National Research Council, the Federal Security Agency and particularly its subordinate unit, the Food and Drug Administration. As the addition of vitamins and minerals to bread and flour adds a few per cent. to the cost of production, a considerable public consciousness of the values it provides is essential to the maintenance and extension of the practice in these highly competitive industries. Further public education is necessary, a task which has been rendered difficult by rival advocacies by nutritionists of whole wheat or of other desirable nutritional reforms. It can not be claimed that enriched bread and enriched flour will correct all the nutritional faults of the nation. It is claimed, however, that this reform is incomparably more important than any other which is feasible of accomplishment within a decade.

There are some other staples which deserve analogous treatment. Addition of vitamin A to oleomargarine and of vitamin D to milk are such worthy projects. Iodized salt is another and there is much to be said for the increments of calcium which self-rising flour and baking powder furnish to the South, especially in areas where the milk supply is low. Because of the extensive occurrence of pellagra among maize eaters, addition of nicotinic acid to corn meal is under consideration. There is no sufficient evidence that rectification of staples should go further than this now. Vitamin C is sometimes too meagerly supplied, but there appears to be no other vehicle so effective as the increased use of fresh fruits and vegetables.

Riboflavin presents a rather peculiar problem. A partial deficiency of it is wide-spread, but we can not definitely lay the blame on any recently introduced food process or new alteration of habit. We need more extensive and more reliable assays of the riboflavin contents of foods. Light destroys this vitamin rapidly and this may be significant during manufacturing and distribution of certain foods. Milk is an excellent prophylactic when available. In normal times there is an enormous amount of skim milk, rich in riboflavin, which is never recovered in dry form or which is devoted to poultry feeds. The principal human use of skim milk powder is in bakery breads.

These and kindred problems of the conservation of the outstanding nutrient components of foodstuffs as related to variety, soil, climate, cultivation, transportation, storage, drying and canning of foods will furnish an enormous grist of work for the food industry laboratories for many years. Only recently have rapid assay methods for the principal vitamins begun to be available for the guidance of such studies. So long as the industries were dependent on laborious and sometimes uncertain animal experiments, progress was necessarily slow. Nowadays the food industry laboratories are turning out vitamin assays in great volume and with increasing precision. In general, these laboratories are able to select their samples for analysis with a far better perspective of the origin, classification, processing and destination of the products than is possible for the academic or government laboratory. Every laboratory performing such analyses should feel an obligation to publish its results for the public good or better still to contribute the analyses toward compilations which are almost constantly in progress in government bureaus.

When such nutritional reforms have been in full operation for some years, the physician will have little occasion to treat deficiencies of the major vitamins. Until that happy day, which must be some years hence, he will encounter an abundance of avitaminoses, especially in clinics for the under-privileged. His immediate task is to recognize the symptoms. If they are mild or mixed, this is usually beyond the average physician of to-day. An increasing number of younger men, however, are well schooled in their

recognition and a host of laboratory methods for confirmation of diagnosis are in use or under development. They include principally optical methods for detection of eye lesions, mechanical tests of the fragility of capillaries and chemical analyses of blood, urine, breast milk and occasional biopsy specimens of tissue. Norms are gradually being established for each of these measurements; knowledge of the vitamin contents of each organ of the human body is slowly accumulating. These studies are not only of diagnostic value for guidance of treatment. They are peculiarly valuable for establishing optimal levels of daily intakes of each of the vitamins in food. Our earlier estimates of the desirable levels were often too low because they were based on findings for individuals then supposed to be normal but now recognized as sub-normal, so wide-spread are some of the deficiencies.

Many individual idiosyncrasies are encountered. Sometimes they may be due to the malfunction of a secretory organ, for example, the thyroid or pancreas. Obviously people suffering from organic disfunction are not immune to vitamin deficiencies. Intestinal sluggishness or hyperactivity often profoundly influences a vitamin economy. To judge from the findings in experimental animals, man's vitamin economy may be greatly affected by the organisms he harbors in his intestines. They may synthesize or destroy vitamins in quantity according to the strains present and the character of the milieu in which they live.

Fortunately for the physician in general practice who naturally can not keep pace with the manifold weekly developments of modern medicine, the therapeutic response of vitamin dosage is very often convincing. If it is not favorable, he may rest assured that he has done his patient no harm and proceed to the next indicated therapy. Often physicians resort to polyvitamin preparations. Knowledge of the nature of the deficiency is thus sacrificed, but the practice is at least in part justified by the fact that deficiencies are often multiple.

Six vitamins have been referred to as major ones. The physician, even in general practice, can not wholly afford to neglect some of the lesser ones. Notably pre-administration of vitamin K to prevent excessive bleeding in childbed is becoming routine in many hospitals.

You are doubtless asking what all this vitamin knowledge will get us in terms of health, strength and longevity. No quantitative estimates are possible. Very few long-term experiments with animals have been carried out since all the major vitamins became available in pure form and since several of the lesser ones have been at least recognized. There is much need for patient and thorough work along these lines. The testimony of the clinics, the results of experiments with school lunches or supplementary feeding, as well as the observation of health trends in nutrition-conscious populations, are very reassuring. Since partial deficiencies are often most apparent in middle or later life when the body mechanism is beginning to feel the strain of the years, it seems reasonable to hope that nutritional reform will extend the span of life measurably. Control of infectious diseases has principally affected mortality in infancy and early life. Those who survive to old age tend to be those who have acquired immunity to infectious disease or at least to have undergone a selection for resistance to disease. In nutritional disease, the phenomenon of immunity is absent. We do not grow accustomed to deficiencies with the years. Early damage remains and later damage accumulates till the slowing bloodstream of age leaves our cells grossly undernourished, so it seems.

I have dealt with what I believe we may do within some years in applying our present knowledge of vitamins to the problems of public health. I would not have you suppose, however, that my imaginative sensibilities are wholly dulled to the possibilities which future pioneering research may bring to light.

The chief product of our studies of vitaminism has perhaps been a knowledge of the nature and behavior of those once quite obscure or unknown substances. Major by-products have been techniques and philosophies.

Of techniques, there are many which have been provoked or promoted by the necessities of vitamin research. One may reflect that, had thiamin been isolated at the time its isolation was first seriously attempted, there was no one in all the world who could have made a competent elementary analysis with any available sample. It was the microanalytical techniques of Pregl and his successors which really gave usefulness to the isolation procedure. But to go back a step further, the isolation itself would have been impossible without an appreciation of adsorption and of hydrogen-ion control. Our knowledge and skill in these matters has been drawn from wide fields, from artificial catalysts, from gas mask construction, from the theory of solutions and the arts of the brewmaster. Yet the needs of vitamin chemistry have aided greatly in forcing a refinement of the methods and a sharpening of the tools. To go a step forward, had we succeeded in our isolation and obtained a significant analysis, we might well have been baffled for an explanation of the peculiar acid-base properties of thiamin had we no glass electrode to run a titration curve with precision, a device which depends for its excellence on recent advances in electrical arts. All this range of techniques has been brought to the ser-

vice of biology in no small measure by the demands of the chemistry of minor organic constituents of living things.

And lastly of philosophy. We have long known there are enzymes and we recognized their analogy of function to the inorganic catalysts brought to light in great measure by Sabatier. The idea that a catalyst and its substrate must have a lock and key relationship arose early, based possibly upon Ehrlich's notions of immune reactions. Nobody, however, could prove the case, for the enzymes appeared to be gross and unmanageable molecules of great complexity. Turning to the inorganic catalysts for analogy did not help much because they obviously involved properties of the surface which were not shared by the interior of the particles. Precise chemistry of the surface, aside from the insides, was a poser. Even the electron microscope has its limitations in dealing with the irregular surface of a dense body.

It remained for vitamin chemistry to furnish the first example of an enzyme with a detachable prosthetic group, a key with the bit detachable from the stem. The bit or coenzyme turned out to be simple enough to be dealt with by classic methods of determining molecular structure; in fact it was a relatively simple derivative of a recently isolated vitamin. A similar relationship to enzymes has been proven for some other vitamins, though not all, and we know from the specificity of the coenzymes that the lock and key idea has validity. It is a notable step forward in enzyme chemistry and seems to offer an entering wedge for an attack on the chemistry even of genetics.

Another philosophy brought into relief by vitamin chemistry is the intimate chemical kinships of all forms of life. This permits the use of any convenient living thing to learn something about the probable behavior of more complex, delicate or unmanageable organisms, such as man. Vitaminism has taught us that metabolism is primarily cellular and not systemic.

It is true that these bits of philosophy are implications of vitamin chemistry and not necessarily integral parts of it. Nevertheless, vitamin chemistry will proudly observe their future progress, assured that presently we shall not attempt to distinguish sharply between vitamins and non-vitamins. That is an accident of the distribution of particular synthetic capacities among living things. We already know there is no sharp division along the borders of the animal and vegetable kingdoms.

VITAMINS IN THE FUTURE[1]

By Dr. ROGER J. WILLIAMS

THE UNIVERSITY OF TEXAS

THERE is an anecdote regarding the president of one of the smaller colleges who was induced to set aside a substantial fund for research. If my hearers can believe the first part of this story, namely, the alleged fact that a president of a smaller college actually found and set aside substantial funds for research, they will find no difficulty in believing the rest of it. It seems that the plea made to this president was that there were *questions* which needed to be answered and research offered the only promise of answers to these questions.

At length the money was spent and more was asked for. But after reading the report the president objected strenuously to an additional appropriation on the basis that while the original purpose of the research was to *answer* questions, the investigators had ended by *asking* more questions than they had answered.

It seems that nowhere has this principle been better exemplified than in the vitamin field. At first the question was asked and answered, "What are vitamins?" Secondly, skeptics challenged the chemist, "Show me *one!*" Parenthetically, I will say I am sure that the first time many people in this country saw a vitamin was when my big brother Bob went traipsing over the country under the auspices of Sigma Xi lecturing and carrying with him a huge bottle of pure crystalline thiamin. People really got an eyeful. I believe he doesn't have his big bottle of thiamin with him this evening. So many people are taking daily doses of it now that it has become unsafe for him to appear with it on the street for fear of being mobbed.

After one or two vitamins had been produced by the chemist, the clamor was "More! More!", and now the chemist is able to show to any skeptical individual about fourteen different, distinct vitamins in crystalline form. In addition, there are interchangeable forms of a number of the fat-soluble vitamins.

On this occasion we want to discuss a few of the questions regarding vitamins which are largely for the future to answer. These questions could never have been *asked* were it not for the knowledge already gained through extensive research. Some are ques-

[1] Address on the occasion of the presentation of the Charles Frederick Chandler Medal of Columbia University, February 26, 1942.

tions of purely scientific interest. Many, however, have import from the standpoint of practical value to society.

Aside from the obvious question of what and how many vitamins exist, one of the most fundamental problems for the immediate future is to find out how vitamins act in the body—not what outward manifestations appear when they are lacking in the diet, but exactly how they function and why are they necessary. Each vitamin will present a more or less distinct answer to this question.

It appears that the "B vitamins," those comprising the group in which my brother and I have been primarily interested, are most fundamental to life. Living organisms are known (yeast is an example) which apparently can live and reproduce indefinitely without having in the cells at any time, so far as we know, any vitamin A, vitamin D or vitamin C. But in yeast and in other lower forms of life the "B vitamins" are, so far as we know, all present and functioning.

I was one of those who a few years back privately objected to jumping to the conclusion that since vitamins are present in tissues in small amounts they therefore are catalysts. It is now clear, however, with respect to several of the "B vitamins," that they do act as catalysts or at least are fundamental parts of catalytic systems. It seems not too dangerous now to infer that the other B vitamins probably act catalytically also. This conclusion does not follow necessarily for vitamin A, vitamin C and vitamin D. The functioning of these is very obscure at present.

We chemists have a simple device for representing a chemical reaction. If substance A is transformed into substance B, we write the formula of substance A, then draw an arrow pointing to the formula of the transformation product, substance B. The arrow indicates the transformation. Some one has defined a catalyst as something which "lubricates the arrow."

Vitamins of the "B group," we may conclude, probably act essentially as highly specialized lubricants for biochemical processes. In keeping with this idea they do not furnish energy but make possible its utilization. They do not function contrary to thermodynamics but make possible the flow of energy through the unbelievably intricate channels of living matter.

But we need a more intimate picture of how each of these vitamins act, what particular processes they lubricate and how they function. In the case of several of the B vitamins an excellent start has already been made; nicotinamide and riboflavin enter into indispensable "lubricants" for oxidative processes; thiamin is a part of a "lubricant" which is essential for decarboxylation mechanisms. However, our picture of why exactly these substances serve as "lubricants" is very hazy.

The case of pantothenic acid will illustrate our need for further knowledge. So far as we are able to tell, it is present in every type of living cell and we are led to assume that it catalyzes certain processes which are essential to life. There are facts which hint that it may be a lubricant for some step in the process of carbohydrate utilization. However, the subject of carbohydrate utilization has been studied extensively; many of the special "lubricants" have been identified and their action studied. Pantothenic acid, as yet, doesn't fit in anywhere in the scheme. So far as we can tell from its structure and chemical behavior it does not possess the properties necessary for an oxidation "lubricant." It doesn't appear to be adapted to receiving or donating hydrogen or electrons, and in this respect it is different from several of the other "B vitamins."

For a long time nutritionists have had some information regarding the functioning of vitamins. When a particular vitamin is lacking from the diet of an animal, it is usually possible to see that something is wrong. Often it is possible to identify the lack by the appearance or behavior of the animal, or the lesions which may appear on its body. When, for example, chicks are kept for a time on a diet relatively free from pantothenic acid, they develop what has become known as "chick dermatitis." But dermatitis, dermatosis or dermapathosis, if you like a more high-sounding word, simply means a diseased skin, and the trouble is much more deep-seated than this. Dermapathosis of one sort or another in one experimental animal or another may be caused by the lack of almost any member of the "B family" of vitamins. The symptoms may involve roughness or cracking of the skin in various areas, development of sores and loss of hair. Closely related is an unhealthy appearance of the hair or actual graying, since hair is a modified epidermal tissue. But in all cases the real trouble is probably not in the skin alone but in every tissue of the body. Naturally when we look at an animal we see the outside covering—the skin and fur. If there is something wrong with every tissue in the body of an animal, including the skin, we notice the skin and diagnose with a grunt of satisfaction—"dermatosis."

Studies made in our laboratory at Texas have showed that both in pantothenic acid deficiency and biotin deficiency not only the skin but every tissue and internal organ is lacking in the essential substance and shows its lack by failure to develop normally. If we were better pathologists we might be able to describe the changed morphology of the various internal tissues induced by the vitamin lack. I suspect, however, that the approach open to the pathologist would not always be a very fruitful one. A house infested with termites and about to fall down because of the

weakness of the timbers could not be distinguished from a building having strong timbers, merely by photographic studies of its exterior. Just so it might not be feasible to distinguish morphologically between healthy cells from those which are deficient in some essential principle.

Physicians have coined the term avitaminosis to designate a diseased condition brought about by the lack of a vitamin. The various "avitaminoses" are poorly characterized indeed when we consider how many tissues may be affected. Superficial appearances and symptoms are wholly inadequate.

A question closely related to the one we have been discussing has to do with how the vitamins are interrelated. Each vitamin in general has been considered to have its individual independent function, and to be required as a separate entity for this reason.

There are some suggestive facts, particularly with regard to the "B vitamins," however, which cause one to be cautious and not too dogmatic. Several years ago we were studying the nutritional requirements of certain mold, and found much to our surprise that whereas it would not grow on a medium containing nothing more "special" than amino acids it would grow when to the medium was added thiamin, pantothenic acid, riboflavin *or* inositol. Growth would initiate when only one (not all four) was added. This observation should not be considered as a very valuable one so far as possible application to animals is concerned, because the mold in question was probably actually capable of synthesizing all four of the vitamins and required one of them only as an initial stimulus. In animals thiamin, pantothenic acid and riboflavin can not be synthesized (the case of inositol is uncertain) and one certainly can not replace another.

Another interesting and suggestive fact is that the various B vitamins are definitely associated together. Our recent studies of the vitamin content of tissues show a definite and often high positive correlation between the vitamin contents of different tissues. Those that are relatively rich in some of the "B vitamins," notably liver and kidney, have a tendency to be rich in all. Tissues such as skeletal muscle have a tendency to be low in all. Heart muscle, incidentally, is almost invariably richer in all B vitamins than skeletal muscle.

We have found also, for example, that feeding hens a diet enriched with respect to pantothenic acid causes the other "B vitamins" to be somewhat changed in their distribution in the chicks hatched from the eggs. This indicates that the different "B vitamins" are not working entirely independently.

The probability that one known vitamin can actually replace another can be pretty well ruled out on the basis of available evidence. We can not be sure, however, that our need for one is not influenced by o supply of another. It is well recognized, of cour that thiamin is essential for carbohydrate metaboli and that on a high fat diet less thiamin is requir If there are vitamins which are peculiarly essential fat metabolism, it is easy to imagine that the amou of these in the diet might affect the thiamin requi ment and *vice versa,* yet neither of the two vitami would be capable of actually replacing the other.

With regard to amino acids, it had become cu tomary to think of them as being in two groups essential and non-essential—until Rose and his c workers showed that arginine is not essential f growth but is essential for *rapid* growth in rats. is one amino acid which can be built up in the bod of rats but not with sufficient readiness to allow rap growth. Is there any parallel in the field of vitamin Are there vitamins which are not absolutely essenti but which are necessary if good performance is to b induced? One reason for thinking that this may is the fact that in yeasts, for example, the phenomen is observed again and again. Biotin, the remarkab potent yeast growth substance discovered by Kögl, so far as I know not required for the growth of a of the yeasts which it stimulates. These yeasts w grow without biotin, and as they grow it is produc in abundance. But biotin is a powerful stimulant yeast growth; it can not be produced by yeast read enough to allow the most rapid multiplication. T most rapid multiplication takes place only when it furnished in the culture medium.

Whether "non-essential" or "optional" vitamins o cur which are effective in animal nutrition is a qu tion for the future. It is entirely possible that so of the lesser known members of the "B family," t status of which is still in doubt, may belong in th category.

Another question arises naturally as a result of o work with microorganisms. Are there such things "anti-vitamins" or inhibitory principles in foods wh affect health and well-being? Of course the existen of a special protein "avidin" in raw egg white, wh is capable of inactivating biotin, has been demo strated, but I am thinking more particularly of lo molecular weight compounds. In laboratory studi with microorganisms (yeasts particularly) we a constantly confronted with the presence in extra of inhibitory substances which profoundly influen growth. We have long suspected that the same similar substances may have an influence on ma malian nutrition, but very little is known about th existence or functioning of such substances.

A field of study which should be pointed out wh we are mentioning microorganisms is that of the ba

rial production of vitamins in the intestines of animals. Of course we must know to what extent this being accomplished before we can have an adequate a of how much of the vitamins are required in the od under different conditions. Elvehjem at Wisnsin and Mitchell at Texas have made recent studies this problem, but I must not tarry on this particur phase of the subject.

I must turn now to a discussion of some of the ossible applications of the new knowledge which I lieve will be forthcoming. One of the subjects hich has been of particular interest to me is that of dividual differences. Vitamin study has not in genal been concerned with this at all. Every attempt s been made in dealing with experimental animals have them as uniform as possible so they will give e same responses. By careful inbreeding and use litter mates for controls much has been accomished in this direction, but even so it is still necesry to use a number of animals if one is to perform conclusive experiment. This merely means that regularities of response are to be expected.

How great a contrast is there, biologically speakg, between an inbred colony of experimental anils and, say, the population of New York City, here even within each of the numerous racial groups here are tremendous genetic differences. But our utritional knowledge when applied must be used in recisely such diverse groups. It may be that some y the medical profession will be able to concentrate s attention upon the very thing that the nutritionist likes to eliminate as completely as possible, namely, e variation in the needs of individuals. There are wo convincing arguments in favor of the therapeutic e of vitamins: one is that they *work* and the other that their use is rational in view of the existence of ndividual differences and exaggerated requirements hich may not be met by ordinary foods. Not only e heritage of an individual but his case history may onceivably make for altered and probably increased itamin requirements.

We know that the chemistry of our individual odies is not all exactly the same, otherwise a bloodound could not use his nose to distinguish between ndividuals. It is a well-known fact, though not lways recognized in practice, that individuals do not ll respond alike to common drugs. I once had a tudent who had his tonsils removed almost without n anesthetic, because the operating physician could ot believe that he was unaffected by novocaine, even hough the fact had been demonstrated previous to his occasion. Curious individual peculiarities sometimes show themselves. I have an acquaintance who, hough his sense of smell is normal in all other known espects, is unable to detect the odor of a skunk. For him, the pure substance n-butyl mercaptan, the active principle of "skunk perfume," has no striking or obnoxious odor. When such remarkable differences exist with respect to other chemical substances it would not be surprising if the vitamin requirements of some individuals deviated sharply from the mean. Virtually nothing is known at present regarding this possibility.

Another field where vitamin study will doubtless find fundamental applications is in chemotherapy. Not many years ago chemotherapy was considered almost a dead issue, with salvarsan and its relatives as the outstanding achievement. In recent years with the advent of sulfanilamide and its relatives chemotherapy is riding the crest of the wave and is more important than ever before.

While the action of drugs is never simple, there can be no reasonable question but that sulfanilamide and related drugs owe their action at least in part to their structural similarity to a vitamin, *p*-amino benzoic acid. It has been demonstrated that sulfanilamide inhibits bacterial growth *in vitro* by blocking out *p*-amino benzoic acid, and that its effects can be neutralized by the presence of an excess of *p*-amino benzoic acid.

Snell at the University of Texas has shown that the sulfonic acid analog of pantothenic acid inhibits the growth of bacteria which require it, and that its effect can be neutralized by additional amounts of pantothenic acid in an exactly analogous fashion.

These facts appear to be the basis for an entirely new approach to chemotherapy. It seems a reasonable working hypothesis to assume that chemical substances which have striking physiological effects have these effects because of their resemblance to naturally occurring tissue constituents, and that many substances of potential therapeutic value will be found which bear chemical resemblances to the various vitamins, of which we now have a considerable variety. If these remarks are valid, chemotherapy can now develop, not in a hit-and-miss and entirely empirical fashion, but by making use of at least one definite guiding principle.

One of the most important applications of vitamin knowledge will be, I believe, to the study of cancer. About a year and a half ago we were enabled, by a generous grant from the Clayton Foundation of Houston, Texas, to start a study along this line.

We felt, and have had no occasion to alter our opinion, that any study of the interrelations between vitamins and cancer must be a thorough one, so that our work in this field is not narrowly confined to cancer as such but also to a better understanding of how vitamins act in normal tissues. We are cognizant of the fact that vitamins which are as yet undiscov-

ered may play a role, so we are interested in these also.

Aside from the development of methods and the study of the vitamin content of tissues, my associates, Drs. Pollack and Taylor, are carrying forward a more systematic study than has ever yet been attempted of the effect of vitamins in the diet on the incidence and development of various types of malignant growth.

In a book from the Bar Harbor Laboratories, published late in 1941, appears the following statement:

> Various experimental, unbalanced and defective diets have been reported as influencing the number of "takes" and the rates of growth of transplanted tumors. There is no doubt that diet may play a part in determining the reaction of the animal. On the other hand, the fact that the investigators have not used inbred strains to reduce and control the genetic variables, leaves it uncertain as to the cause and effect relationship between diet and changes in percentage of growth. This fact, coupled with an almost complete disregard of criteria of mathematical significance between the groups that are being compared, seems to have left the problem of diet in a most unsatisfactory condition. For this reason no attempt is made in this volume to cover the extensive but non-critical bibliography. The whole problem will have to be approached "from the ground up" by investigators who understand and utilize genetics, biochemistry and mathematics.

We were pleased when we read this because it coincided with our ideas and we had in fact just planned extensive experiments along exactly the lines suggested. These experiments are now under way and the results will be reported in due time. There are various groups of workers interested in essentially the same problem. It has been demonstrated many times that diet and specific vitamins affect the incidence and development of cancers induced by feeding butter-yellow. Our work as well as that of others indicates that the vitamins in the diet make a difference in cancers other than those induced by butter-yellow. We can not say yet just what the total results of our rather comprehensive experiments will be, but we can already be sure of one thing. They will be interesting.

A pet thought of mine which it seems appropriate to mention on this occasion is that one of the most important borderline fields in the future will be that existing between biochemistry and psychology. In this particular field vitamins will probably play an interesting role.

We have noted in our laboratories "personality differences" developed in experimental animals apparently as a result of diet. I presume similar observations have been made elsewhere. It is well recognized that good health and good dispositions tend to go together, and in so far as an abundant supply of vitamins may foster good health it will also promote good psychological adjustments. The current view with regard to psychological disturbances is that they are essentially pathological and amenable to treatment just as other ills are. It is a truism that mental health is based upon bodily health, and there are some good reasons for thinking that vitamins may in the future contribute materially to mental health and to satisfactory psychological adjustments. It is recognized already that one vitamin can and does cure mental derangements. One of the most distressing symptoms of pellagra are the hallucinations, dreams and other mental symptoms. These are tremendously helped by nicotinic acid administration. People who were so "crazy" as to be totally incapacitated have been brought back to the point where they can perform the functions of a useful member of society. What other vitamins may do for mental ills is yet to be demonstrated.

It should be pointed out that good diets, which mean an abundant supply of vitamins, among other things, promote intellectual keenness as measured by psychological tests both on animals and human beings. There can be no doubt that much dullness on the part of school children, particularly among the lower income groups, can be traced in part to a lack of the proper kind of food and specifically to the lack of enough vitamins.

We may as well end this part of the discussion on as lofty a plane as possible. Recent studies, several of them in New York City, have shown without question that intelligence and morality go together. The more intelligent a child is the less is his tendency to cheat, lie, steal or become delinquent. This high correlation between intelligence and morality can lead us to one conclusion. Since an ample supply of vitamins can foster a higher intelligence in human subjects it has also the capability of fostering morality. Vitamins in the future will not only give people better health both bodily and mentally but will increase their intelligence and their morality. It remains for the future to show to what extent these ends can be accomplished and how useful vitamins will be as tools for their accomplishment.

OBITUARY

JACOB ELLSWORTH REIGHARD

AFTER an illness of some weeks, Professor Jacob Ellsworth Reighard died on the 13th of February, 1942, in his eighty-first year. Thus passed a leader in the field of ichthyology, fresh-water biology, animal behavior and evolution—a man whose biography

would involve a considerable portion of the history of the department of zoology at the University of Michigan.

Born of Pennsylvania parents at LaPorte, Indiana, on July 2, 1861, trained at Michigan and at Harvard under E. L. Mark, and with a background of two years as a private tutor and one year of high-school teaching, this enterprising young zoologist returned to the University of Michigan as instructor in 1886. He was given the title professor of animal morphology in 1892, and professor of zoology, director of the zoological laboratory and director of the museum of zoology in 1895. His directorship of the museum was relinquished in 1913, and that of the zoological laboratory in 1925, though he continued as an active member of the staff until his retirement in 1928.

Professor Reighard's interests were varied through his lifetime, but the phases of his activities were rather sharply marked off from one another. He concentrated on one thing at a time. A chronological list of his publications would appear to indicate a considerable overlapping of these phases, but it would be deceptive because of delayed publication. A number of times in his career he published from data that had been in his files for many years. It was obvious to his colleagues that preparation of such delayed papers was to him a peculiarly onerous type of drudgery, to which he drove himself with a feeling that it was his duty to put his accumulated information on record.

His early investigations were on the embryology and morphology of fishes, which involved naturally the taxonomy of that group. From 1890 to 1895 he was in charge of the scientific work of the Michigan Fish Commission, and from 1898 to 1901 directed the Biological Survey of the Great Lakes conducted by the U. S. Fish Commission. Interest in fish led him to studies of plankton, originally as fish food but later as a component of fresh-water communities in general and as important material for investigation of fresh-water biology *per se*.

Difficulty with his eyes led Professor Reighard to abandon indoor, particularly microscopic, work and to take up outdoor studies. A notable feature of these new investigations was that they were performed with the same critical standards, the same meticulous attention to any detail which might later prove important, the same rigid requirements for sound judgments which had characterized his laboratory studies. Laboratory methods were being transported into nature, where they served as a model for a then relatively new type of outdoor work.

The field studies naturally revolved around fishes and were concerned largely with breeding behavior. Nest building and the courtship and other mating activities of a number of different fishes, and lampreys, were carefully observed. The heightened color of some fishes at the breeding season led Professor Reighard, with certain of his students, to a critical study, first, of the psychology of color vision in fishes, and later of the significance of color in evolution. Under the latter rubric comes his notable reexamination of the supposed warning color of brilliant small coral-reef fishes. In this study he showed that it was not the color of these fishes, but the presence of the reefs, which saved them from attack, and he was led to formulate the theory of immunity color to replace warning color in this particular situation. The coral-reef experiments were judged by eminent contemporaries to be the "most important experimental study of natural selection" (Pearl) and the "best work done at the Tortugas Laboratory" (Mayor) up to that time.

His teaching mostly concerned the vertebrate animals. Once his principal course was on vertebrate (with emphasis on mammalian) anatomy. As his interests changed to outdoor studies, his main course was called simply vertebrate zoology, which included habits as well as morphology. This was later transformed into natural history, which included some invertebrate fresh-water ecology. The field thus covered was unwieldy, and the invertebrate part was split off (eventually changing to limnology, given by others), while the vertebrate part continued as vertebrate natural history. On Professor Reighard's retirement, the latter course was taken over and developed by the late Professor F. N. Blanchard. For many years Professor Reighard gave also a semi-popular course on evolution.

Late in his active life a growing deafness deprived Professor Reighard of many of the ordinary human contacts. He was stimulated to an effort to aid others similarly afflicted, and devoted much time to learning lip reading, to writing articles on the place of speech reading in schemes of education and to translating important foreign-language works in that field.

Mention should be made of one important service for which, in some circles, Professor Reighard was better known than for any other—the publication, with Herbert S. Jennings, of "The Anatomy of the Cat." This book was for many years the standard work for courses in vertebrate anatomy. Classes were small, however, and the book was never an important source of income for its authors, for it was many years after first publication that the senior author humorously displayed to his colleagues the first royalty check for a few dollars. In recent years, after a third of a century of use, this book has been revised by Dr. Rush Elliott in close cooperation with Professor Reighard and is again offered to students of mammalian anatomy.

Throughout his scientific career Professor Reighard

showed keen interest in the invention and construction of technical apparatus for use in investigations. Photography was the outlet for much of this natural bent, and several publications on the technique of obtaining photographs of biological material resulted. One of these was devoted to underwater photography. In his plankton work he introduced the new European methods to America and made important improvements upon them by modifications of equipment. In the coral-reef studies he contrived an ingenious device for recording his observations without taking his eyes off the fish. When the Natural Science Building at the University of Michigan was built and equipped, his mechanical propensities found expression in the design of the photographic and preparation rooms and their apparatus.

Scientific organizations have felt the influence of Professor Reighard's career in no small measure. Locally he helped found the Michigan Academy of Science in 1895 and was one of its early presidents; he was one of two coinstigators of the founding of the Research Club of the university and appeared repeatedly on its programs, and was active in the Michigan chapter of Sigma Xi. He was largely responsible for the establishment of the university's biological station in northern Michigan in 1909, and was its director the first six years (though resident at the station only three of these). Beyond the university's immediate domain, he was president of the central branch of the American Society of Zoologists, president of the American Fisheries Society and vice-president and chairman of Section F of the American Association for the Advancement of Science; and he presided at two sessions of the section on animal behavior of the International Zoological Congress in Boston in 1907.

Professor Reighard was an outdoor man in recreational as well as scientific ways. Member of a local club having properties on a group of nearby lakes, he could frequently be found living for weeks at a time in its cottages. Journals of some of his camping trips with friends, and appended lists of equipment for the instruction of other campers, have been preserved among his papers. He was instrumental in forming a faculty club, with fencing, boxing and the broadsword as leading activities; but when this later led to the establishment of a university club with social functions, he gradually lost interest in it. Never an effusive person who made friends by sheer charm of manner, he was nevertheless one of a considerable group of loyal and devoted persons among whom there was genuine and strong affection—a fact well demonstrated at a testimonial dinner given him a year or so before his retirement, at which "Old Friends" participated to an important degree. His scientific attitude was one of rigorous discipline; nothing was proved, in his estimation, short of proof. In his middle and earlier years his colleagues may have felt his driving industry, but he drove himself more than he drove any of them.

The passing of Professor Reighard will be regarded as a milestone in the progress of some of his fields of interest, in which there have followed still greater developments than any attained in his time. In others his work must still be seen in retrospect as a model scarcely equaled since, and, hopefully, as a stimulus to further advance.

A. FRANKLIN SHULL

REMEMBERING WILLIAM JAMES

THE *Harvard Alumni Bulletin* calls attention to the fact that January 11, 1942, marked the hundredth anniversary of the birth of William James, American philosopher. The *Bulletin* states that weeks before the actual date, societies, libraries, university departments and colleges the country over began to celebrate —as they are still celebrating—this significant event. William James taught at Harvard from 1872 to 1907, retiring as professor of philosophy emeritus.

A conference on methods in philosophy and the sciences was held in New York City at the New School for Social Research on November 23, 1941. One of the symposium titles was "Remembering William James," and the five speakers included Henry James, '99, of the Corporation; Dickinson S. Miller, '92, and Professor John Dewey of Columbia. On December 29, 1941, at Vassar the forty-first annual meeting of the American Philosophical Association held a William James symposium. Two of the speakers were Harvard teachers: Professor Ralph Barton Perry and Associate Professor Donald C. Williams. A William James exhibition opened at Widener Library on January 2. At the Harvard Club of New York, the club library held a special exhibition during the month of January of "Books Annotated by Great Harvard Scholars," centering on a few books comprising the William James collection in the Harvard College Library.

Then a William James centennial program was given by the department of philosophy in the University of Wisconsin, January 10, largely arranged by Professor Max C. Otto of that university. At Norwich University, January 11, the department of philosophy and psychology held a meeting in commemoration of William James. Professor J. Seelye Bixler, president-elect of Colby College, spoke at Colby (January 17); at the same time an exhibition of letters of William James and his father, Henry James, was arranged at the Colby Library. Scripps College in California carried out a centennial program, January 11, of which William Bennett Munro, Ph.D., '00, of the California Institute of Technology

(formerly a member of the Harvard faculty), was the honorary chairman. Professor William E. Hocking spoke on "William James' World-View."

Professor Hocking also opened a series of symposium lectures at Harvard, "William James and the Psychology of the Present," on January 28. Twelve men are contributing to the series, in which five lectures have already been given, with seven to come, concluding on April 22. In September the American Psychological Association will celebrate the James anniversary at Harvard, with James R. Angell, formerly president of Yale, as chairman.

RECENT DEATHS

EDWARD C. SCHMIDT, who retired two years ago as professor of railway engineering at the University of Illinois, died on March 21. He was sixty-seven years old.

DR. MARTHA TRACY, assistant director of the Public Health Department of Philadelphia, died on March 22, at the age of sixty-five years.

DR. GEORGE SHIRAS, 3D, of Marquette, Mich., known for his flashlight photographs of wild animals, died on March 24, at the age of eighty-three years. He had made biological expeditions to Newfoundland, Alaska, the West Indies, Mexico, Panama, Hawaii and the Rocky Mountains.

DR. I. SETH HIRSCH, since 1933 professor of radiology at the New York University College of Medicine and a practicing physician in New York City for forty years, died on March 24, at the age of sixty-one years.

THE death is announced of Professor Sir Robert Chapman, since 1939 president of the South Australian School of Mines.

SCIENTIFIC EVENTS

PHYSICIANS FOR THE GOVERNMENT SERVICES

IT is reported in *The New York Times* that at a meeting of the Medical Society of the County of New York at the New York Academy of Medicine, Colonel S. F. Seeley, of the Army Medical Corps and the executive officer for the Procurement and Assignment Service for Physicians, Dentists and Veterinarians, a branch of the Federal Security Agency headed by Paul V. McNutt, announced that a questionnaire will be sent to every physician, dentist and veterinarian in the United States during the first week in April by the Procurement and Assignment Service, Washington, "designed to give an opportunity to the 270,000 persons in these professions to state their preference, should they be called, whether in military, governmental, industrial or civil activity."

Colonel Seeley said:

For the first time in history there is now to be concentrated in one office the data on the availability of professional men to supply the needs of the Army, Navy, U. S. Public Health Service, U. S. Civil Service Commission, Veterans Administration, U. S. Children's Bureau, physicians and dentists and veterinarians and other government services.

No service will commission or employ a person unless cleared by this Procurement and Assignment Service. This immense mobilization must be accomplished without the least jeopardy to the communities from which the men are taken.

The Navy will need a total of 3,000 doctors when its enlistment of 500,000 is reached. For the Army, 16,000 new physicians must be supplied by December 1.

Nearly two years ago the American Medical Association sent out a questionnaire and elicited replies from more than 159,000 physicians in the nation, of whom more than half were willing to volunteer for medical service in case of war. Of the 62,000 under the age of 45, 63 per cent. of the unmarried and 48 per cent. of those married even at that early date before war seemed probable, twenty-two months ago, were willing to offer their services.

Colonel Seeley stated further:

Many physicians are especially interested in aviation medicine. Information blanks may be procured from the Office of the Air Surgeon, Army Air Force, Washington, D. C. Last week my office received a request for 2,500 medical officers for service with the Air Corps by July 1, and to provide 600 per month for the balance of the year. Of the men selected, 80 per cent. must be under 36 years, 20 per cent. may be selected from the group between 36 and 45 if they are recognized specialists, particularly in traumatic surgery, ophthalmology or neuropsychiatry.

No man will be assigned to duty if he is essentially needed on the staff of a teaching institution, industrial plant, hospital staff, public health service or in private practice, unless he can be replaced. But it is expected that all such positions ultimately can be filled by men over forty-five years, or those physically unfit for service under that age, and by women doctors, of whom the nation now has 8,000 in active practice.

A NEW BOTANICAL HALL AT CARNEGIE MUSEUM

THE Carnegie Museum, Pittsburgh, according to *Museum News*, has transformed its Botanical Hall so completely as to make it a new hall both in installation and architectural design. Daylight has been eliminated by closing all the windows with solid stonework; an illusion of spaciousness has been given by a concave dome-like ceiling over an octagonal opening in a

false ceiling, thus combining flat and concave effects. An effective system of ventilation has been added. The habitat groups now appear as openings in the walls of the gallery instead of as individual protruding boxes. The effect is a pleasing continuity. Reflections on the glass are eliminated by interior case lighting. Labels by Curator O. E. Jennings contain explanatory transparencies in color photography that enable the visitor to identify individual plants and the occasional animal forms introduced into the settings. Full-sized groups installed are the Florida group, the Pennsylvania bog, the spring flora of Pennsylvania, Mount Rainier and Arizona. Three additional full-sized groups are proposed, and the space left for these is now occupied by miniature dioramas showing Arctic tundra, the slope of Pennsylvania Laurel Ridge Mountain and Presque Isle Peninsula on Lake Erie. Other exhibits in the room include enlarged models of flowers and maps showing vegetational regions. An octagonal block of benches occupies the center. Plans are ready for two gallery floors and await only the necessary funds for work to begin. Frank A. Linder developed the plans and supervised construction of the Botanical Hall, which was a WPA project. Roy B. Ambrose, of the building staff, helped in the technical problems. Ottmar F. von Fuehrer, staff artist, created the exhibits with the help of Mrs. Fuehrer and Carl Beato, under the general direction of Mr. Jennings. For the Arizona group alone Mrs. von Fuehrer and Mr. Beato fashioned some 12,600 separate pieces.

THE HALL OF NORTH AMERICAN MAMMALS OF THE AMERICAN MUSEUM OF NATURAL HISTORY

AFTER six years of construction and preparation, the new hall of North American mammals in the American Museum of Natural History will be opened to the public on April 9. The first completed habitat groups (ten in number) of what is eventually expected to be the world's finest representation of North American animals housed in one exhibition hall, will be dedicated by officials of New York City and trustees of the museum on April 8.

The new hall is a panorama of wildlife throughout the entire continent, extending from Ellesmere Land, near the North Pole, to Mexico; and from New York State to the west coast of Alaska. As in the Akeley African Hall on the floor above, the animals are mounted in realistic life settings of their native plains, forests, swamps, mountains and deserts.

More than eighteen years ago, Dr. Harold E. Anthony, curator of the department of mammals, outlined plans for a new and modern hall of North American mammals to replace the old interpretation and "stuffed animal" appearance of exhibitions shown in the old mammal hall, built in 1890.

Realizing also that in many instances America's wildlife is still continuing to disappear before the advance of civilization as well as through changing climatic conditions governing the native habitats of these animals, F. Trubee Davison, president of the museum, since the summer of 1935 has directed its expedition program principally to the North American continent for extensive collections of our existing animals.

In 1937 Mr. Davison enlisted the active support of officials of New York City and those who wished to see American mammals preserved in life-like settings for future generations that may not have the opportunity of knowing the living animals.

Without funds contributed by the City of New York for the construction of cases, obtained through the efforts of Mayor Fiorello LaGuardia, Commissioner Joseph T. McGoldrick and Commissioner Robert Moses, the new hall could not have been built. Under the leadership of the Trustees' Committee of North American Mammals eighteen expeditions have collected for the ten habitat groups now completed and eight to be opened in the near future.

The designs, preparation and presentation of the groups were carried out by Dr. James L. Clark, head of the Department of Arts and Preparation, assisted by Albert E. Butler and under the scientific direction of Dr. Harold E. Anthony. Engineering and construction were in charge of Rex Johnson, general superintendent, assisted by Victor Ronfeldt, mechanical superintendent, and Wilson L. Todd, power plant engineer.

The animals were mounted by sculptor-taxidermists, Robert H. Rockwell, Gardell D. Christensen, George Adams and Waddy McFall. Artists who painted the background scenes, in most cases made from their own expedition field-paintings, were Belmore Browne, Charles S. Chapman, Carl Rungius, James Perry Wilson, Francis Lee Jaques, Joseph M. Guerry and Frederick Scherer.

Those who participated in the making of flora and foreground accessories were: Albert E. Butler, George E. Petersen, Raymond H. De Lucia, G. Frederick Mason, Ralph Mendez, Robert Scherer, Charles Tornell, Robert Sewell, Bernard Chapman, Rudolph Freund and James Carmel.

THE NATIONAL RESEARCH COUNCIL'S COMMITTEE ON THE APPLICATIONS OF THE ELECTRON MICROSCOPE

THE electron microscope has opened up for investigation a new order of submicroscope dimensions. Within this range are minute structures of interest in most, if not all, fields of natural science. Interpretation of electron micrographs involves new problems; these arise primarily from the complexities of

the instrument itself and secondarily from the unfamiliar nature of the minute structures under study.

The National Research Council's Committee on Applications of the Electron Microscope, in order to help clarify these problems, hereby offers the services of its members as referees on articles on electron microscopy. The members of the committee are:

Stuart Mudd, *chairman,* department of bacteriology, University of Pennsylvania.

R. B. Barnes, American Cyanamid Company, Stamford, Connecticut.

M. Demerec, Station for Experimental Evolution, Carnegie Institution of Washington, Cold Spring Harbor, Long Island, N. Y.

Henry Eyring, department of physical chemistry, Princeton University.

Robert F. Griggs, department of botany, George Washington University.

Caryl P. Haskins, Haskins Laboratories, 480 Lexington Avenue, New York, N. Y.

Michael Heidelberger, department of biochemistry, Columbia University.

Loyd Jones, Eastman Kodak Company, Rochester, N. Y.

C. W. Metz, department of zoology, University of Pennsylvania.

Katherine Polevitsky, Dental School, University of Pennsylvania.

Thomas M. Rivers, Rockefeller Institute for Medical Research, New York, N. Y.

Gordon H. Scott, School of Medicine, Washington University.

W. M. Stanley, Rockefeller Institute for Medical Research, Princeton, N. J.

Francis O. Schmitt, department of biophysics, Massachusetts Institute of Technology.

V. K. Zworykin, Research Laboratories, RCA Manufacturing Company, Incorporated, Camden, N. J.

T. F. Anderson, *secretary,* Research Laboratories, RCA Manufacturing Company, Incorporated, Camden, N. J.

Editors who care to avail themselves of this offer may send manuscripts to the secretary of the committee, Dr. T. F. Anderson, for reference to an appropriate referee from among the committee's membership.

THE UTAH CHAPTER OF THE SOCIETY OF SIGMA XI

THE Utah State Chapter of the Society of the Sigma Xi, the eighty-second chapter to be established in the society, was installed at the Utah State Agricultural College at Logan on March 14 by Dean Edward Ellery, member of the executive council of the society. The new chapter has fifty-five charter members who are alumni of eighteen other chapters.

At a convocation held in the morning in the college auditorium, Dr. Elmer George Peterson, president of the college, addressed the delegates and members on the subject, "The Place of Research on the Utah State Agricultural College Campus," and Dean Ellery spoke on "Sigma Xi, its Past in Peace, its Present in War."

After the formal installation exercises in the afternoon, a reception honoring the members of the new chapter was given by the faculty association in the reception room of the Commons building. A formal dinner in the evening, presided over by Dr. Sherwin Maeser, president of the new chapter, was followed by the club and chapter's fourth annual Sigma Xi lecture, "The Structure of Liquids," by Dr. John J. Kirkwood, of Cornell University.

Other new officers in the club are: Dr. R. J. Evans, *Vice-president;* Dr. J. Stewart Williams, *Secretary;* Dr. Dean F. McAlister, *Treasurer,* and Dr. Marion T. Bird, *Member of the Council.*

THE SOUTHWESTERN DIVISION

THE twenty-second annual meeting of the Southwestern Division of the American Association for the Advancement of Science will be held under the presidency of Dr. W. M. Craig, of Texas Technological College at Lubbock, at the New Mexico State College of Agriculture and Mechanic Arts at Las Cruces from April 27 to 30. Dr. H. P. Mera, of the Laboratory of Anthropology, Santa Fe, is vice-president of the division and Dr. Frank E. E. Germann, of the University of Colorado, is secretary.

The division meets in four sections—the Biological Sciences, Mathematics, the Physical Sciences and the Social Sciences. Meeting in association with the division will be: The Clearing House for Southwestern Museums, *chairman,* F. H. Douglas, Denver; the Mathematical Association of America, *chairman,* Roy MacKay, State College; the American Association of University Professors, *chairman,* G. L. Guthrie, State College; the State College Biological Society, *chairman,* P. J. Radosevich.

According to the tentative program, in addition to the section meetings on April 28 and 29 there will be on Monday, April 27, a reception for members and guests by Dean and Mrs. J. W. Brannon, and the dinner of the American Association of University Professors in the evening. The following evening will be devoted to the thirteenth John Wesley Powell Lecture. The annual banquet of the division will be given on the evening of the 29th when Dr. Craig will deliver his address as retiring president. He will speak on "The Rôle of Spectrography in National Defense."

Field trips will be arranged to meet the interests of members. Old Mesilla and the ruins of Forts Selden and Fillmore are places of historical interest. The Sunken Mesas, Lava Flows and the White Sands National Monument are features of concern to both

geology and biology. The Conkling Cave, Jornada Experimental Range and the industrial and other interests of El Paso and Juarez, Mexico, may be visited within a few hours. The Carlsbad Cavern trip requires an entire day.

The Mesilla Valley offers an environment rich in anthropological remains and historical landmarks. The White Sands National Monument contains 274 square miles of dazzling white gypsum sands and a lake of unusual setting and beauty. Conklin's Cave in Bishop's Cap of the Organ Mountains was used for years by Indians and Mexicans for shelter. The village of "La Mesilla," two miles southwest of Las Cruces, was settled by Mexican colonists in 1854. Excursions are planned to these points as well as to the Jornada Experimental Range, which embraces experimental projects of the U. S. Forest Service and the New Mexico Agricultural Experiment Station.

MEETING OF THE EXECUTIVE COMMITTEE OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE executive committee met in New York on March 15. The following members were present: Drs. Livingston, *chairman;* Caldwell, Cannon, Cattell, Compton, Long, Moulton and Wrather.

Among items of business of interest to scientific men transacted by the committee are the following:

The president of the University of Michigan having withdrawn the invitation to the association to meet at Ann Arbor in June, owing to war conditions and a change in the schedule of sessions at the university, it was voted to cancel the Ann Arbor meeting.

A committee of three, consisting of Drs. Long, *chairman,* Livingston and Moulton was appointed to have charge of making arrangements for a local committee for the New York meeting at the end of the present year.

On nomination of the Section Committee of the Section on Chemistry, Dr. Hugh S. Taylor (M28, F28), Princeton University, was elected vice-president of the Section on Chemistry for 1942 in the place of Dr. Joel H. Hildebrand. Dr. Wade W. Oliver (M11, F27), Long Island College of Medicine, Brooklyn, N. Y., was elected vice-president of the Section on Medical Sciences for 1942, in the place of Dr. H. S. Gasser. On recommendation of the Executive Committee of the Section on Agriculture, Dr. W. A. Albrecht (M18, F24), University of Missouri, was elected secretary of the Section on Agriculture to fill the unexpired term of Dr. M. F. Morgan, resigned to serve as an officer in the U. S. Infantry. Dr. Sydney S. Negus was reappointed director of the Press Service for the New York meeting.

The status of the American Society of Plant Taxonomists was changed from an associated society to an affiliated society. The Washington Academy of Science was affiliated on the same basis as state academies.

The Permanent Secretary reported the approval of the Executive Committee by mail ballot of the publication of the Symposium on Relapsing Fever, organized and presented by the Section on Medical Sciences at the Dallas meeting.

On a request from the editors of "American Men of Science," the Executive Committee authorized the president (Dr. Compton) to appoint a committee, of which he will serve as chairman, to advise the editors regarding the subdivisions of science for classifying entries, the advisability of continuing the stars, and, if they are to be continued, the method of selecting them. The committee was requested to deliver its recommendations direct to the editors.

By a majority of 7 to 1, the Executive Committee authorized and directed the Office of the Permanent Secretary to publish and have mailed to all members of the association about the middle of each month an eight-page bulletin of the same general format as the journal SCIENCE.

It was voted to hold the next meeting of the Executive Committee in New York City at 10:00 A.M. on Sunday, October 18, unless in the interim an emergency requires that a meeting be held earlier.

SCIENTIFIC NOTES AND NEWS

THE twenty-fifth anniversary as dean of Columbia College of Dr. Herbert E. Hawkes, professor of mathematics, will be celebrated by alumni, faculty and undergraduates at a dinner to be given in his honor on April 16.

J. B. DAVIDSON, head of agricultural engineering at Iowa State College, has been elected a foreign member of the Royal Swedish Academy of Agriculture.

THE Jackson-Gwilt Medal and Gift of the British Royal Astronomical Society has been awarded to Dr. R. L. Waterfield "for his general contributions to astronomy, and in particular for his photographic work on eclipses and comets and his visual observations of planets." The medal will be presented to him on April 10 at the annual general meeting.

Nature reports that the Royal Society of Arts has awarded the annual Thomas Gray Memorial Trust Prize for an invention advancing the science or practice of navigation to T. E. Metcalfe, of Windsor, for a seaman's protective suit devised by him.

THE University of London has conferred the degree of doctor of science on Dr. G. W. Scott Blair, National Institute for Research in Dairying; Dr. A. H. Cook, Imperial College of Science and Technology; C. L. Hewett, Royal Cancer Hospital (Free) and the Sir John Cass Technical Institute; Alexander King, In-

perial College of Science and Technology; M. A. Phillips, Battersea Polytechnic; Dr. Eugene Rothstein, Imperial College of Science and Technology; Dr. Frank Smithson, Birkbeck College, and Professor F. R. Winton, university professor of pharmacology in University College.

DR. CHARLES F. BÖDECKER, of Columbia University, has been elected president of the International Association for Dental Research. Other officers elected are: Dr. Philip Jay, the University of Michigan, *President-elect;* Dr. H. Trendley, dean, U. S. Public Health Service, *Vice-president,* and Dr. E. H. Hatton, of Northwestern University, *Secretary.*

IT is stated in *Nature* that Colonel S. J. Thompson, governing director of Messrs. John Thompson, Ltd., Wolverhampton (water tube boilers, motor frame pressings, etc.), has been elected president of the British Institution of Mechanical Engineers, London, in succession to W. A. Stanier, chief mechanical engineer of the London Midland and Scottish Railway, whose term of office has expired.

DR. W. W. C. TOPLEY, secretary of the Agricultural Research Council, formerly professor of bacteriology and immunology at the University of London, director of the division of bacteriology and immunology of the London School of Hygiene and Tropical Medicine, has been elected to an honorary fellowship of St. John's College.

DR. JAMES H. ELDER, of the department of psychology of the University of Virginia, has become assistant professor of psychology at the Louisiana State University.

DR. A. C. HARDY, professor of zoology and oceanography at University College, Hull, has been appointed to the regius chair of natural history at the University of Aberdeen. He will become honorary director of oceanographical investigations at Hull. Dr. Hardy's work on the North Sea plankton will be continued by C. E. Lucas, chief of the research staff, who will be in charge.

DR. EDWARD BERNECKER, general medical superintendent of the hospitals of New York City, has been appointed by Mayor LaGuardia to succeed Dr. Willard C. Rappleye as commissioner of hospitals. He has been connected with the hospital department for twenty-seven years.

DR. WILLIAM M. LEPLEY, assistant professor of psychology at the Pennsylvania State College, has received a commission as Captain in the U. S. Army Air Corps. He left the college on March 1 for Kelly Field, Texas, where he expects to be associated with the classification work.

BROOKE DOLAN, II, research associate in mammalogy in the Academy of Natural Sciences of Philadelphia, has been commissioned a lieutenant in the U. S. Army Air Corps. Mr. Dolan has explored and collected for the academy in Western China and Tibet, being the collector and donor of the panda group.

DR. ELIOT ROUND CLARK, professor of anatomy in the University of Pennsylvania School of Medicine, Philadelphia, delivered on January 16 the sixth Adam M. Miller Memorial Lecture at the Long Island College of Medicine. It was entitled "The Behavior of Cells and Tissues in the Living Mammal as Observed through the Microscope."

DR. H. SPENCER JONES, Astronomer Royal of Great Britain, delivered the Symons Memorial Lecture of the Royal Meteorological Society on March 18. He spoke on "The Atmosphere of the Planets."

THE fifth series of the John Wyckoff Lectures at the New York University College of Medicine was delivered on March 24 and 25 by Dr. Richard P. Strong, professor emeritus of tropical medicine at the Harvard Medical School. His subject was "Tropical Diseases and the War." The first lecture discussed dysentery, typhus fever and plague, and the second, trypanosomiasis and onchocerciasis. These lectures were established by the Phi Delta Epsilon Fraternity in 1937 in memory of the late Dean John Wyckoff.

DR. HERBERT M. EVANS, Morris Hertzstein professor and director of the Institute of Experimental Biology of the University of California, is giving from March 24 to May 18 Sigma Xi lectures at the following colleges and universities: Louisiana State University, the University of Georgia, St. Louis University, the University of Missouri, the University of Minnesota, Michigan State College, Bucknell University, the University of Maryland, the University of Pittsburgh, Northwestern University, Kansas State College, Western Reserve University, the Ohio State University, the College of Medicine of the University of Illinois, the University of Colorado, the University of Utah, the State College of Washington, the University of Oregon and the University of Washington.

THE American Geophysical Union will hold its twenty-third annual meeting in the Hall of Government, George Washington Union, Washington, D. C., on April 3 and 4. In addition to the regular scientific sessions of the eight sections, there will be an evening lecture session on Friday, April 3, at which the fourth award of the William Bowie Medal will be made and an address by the president of the union, Dr. W. C. Lowdermilk, on "The American Geophysical Union in its Relation to the Present World Situation," will be given. This will be followed by an illustrated lecture by Dr. Bradford Washburn, director of the New

England Museum of Natural History, entitled "Recent Explorations in the Mountains and Glaciers of Alaska."

THE eighteenth meeting of the American Heart Association will be held on June 5 and 6, at Chalfonte-Haddon Hall, Atlantic City, N. J.

THE thirty-fifth annual meeting of the American Home Economics Association will be held in Boston from June 21 to 24 under the presidency of Dr. Gladys Branegan, dean of the Division of Household and Industrial Arts, Montana State College, Bozeman. The one hundredth anniversary of the birth of one of the founders of the association, Ellen H. Richards, home economist, for many years a member of the department of chemistry of the Massachusetts Institute of Technology, will be commemorated at the meeting.

THE personnel of the field party which the Armour Research Foundation is sending to Argentina at the end of the month to make an industrial survey of the country has been announced. This survey will be coordinated with a further study of projects by the entire staff of the foundation, which is affiliated with the Illinois Institute of Technology. Dr. Francis Godwin, assistant director of the foundation, will lead the field party. He will work in the field of chemical engineering; Dr. John A. Schellenberger, director of biochemistry for the Rohm and Haas Company, in the field of agricultural biochemistry; and Dr. John A. Hopkins, who has leave of absence from the Iowa State College at Ames, in the field of agricultural and industrial engineering. It is estimated that the work will require from six months to a year. Buenos Aires has been designated as headquarters, but the party will travel and work throughout the entire country. Dr. Martin H. Heeren will direct the coordination of interrelated activities in Chicago.

THE *Journal* of the American Medical Association states that a group of Latin American physicians and scientific workers met recently in Buenos Aires under the presidency of Dr. Angel H. Roffo, director of the Instituto de Medicina Experimental of Buenos Aires, to organize a Pan American Scientific Confederation for the discussion of scientific Pan American problems.

THE Federal Civil Service Commission announces that the number of technologists on the employment lists now established is not sufficient for war-time needs. Accordingly, it has recently slightly modified the requirements for these opportunities for Government employment. Salaries for the positions range from $2,000 to $5,600 a year. Applications may be filed at the Washington office until further notice. By technologist is meant a person experienced in "the necessary production, engineering and scientific research work essential for the successful operation of an industrial plant, where such plant operation is based upon a thorough and expert knowledge of a branch of an applied science," such as explosives, fuels, plastics, rubber, minerals or textiles. For the Junior positions ($2,000 a year), applicants will no longer have to take a written test, and, as before, no written test will be given for the higher positions. The maximum age limit for all the grades has been raised to 60 years.

THE employment bureau of the Society of American Bacteriologists has been transferred to Princeton and placed under the direction of Dr. Frank H. Johnson. In view of the present circumstances, leading to frequent changes in positions, special efforts have been made to enlarge the facilities and to enable the bureau to operate efficiently in aiding both employers with vacancies to fill, and applicants for positions in bacteriology and related fields, to secure prompt and satisfactory placements. The bureau will continue on its non-profit basis, which requires only a very small percentage of the salary of successful applicants for jobs, as a means of defraying operating expenses.

THERE is a demand for information as to current wildlife research being conducted throughout the United States. In order to supply this the U. S. Fish and Wildlife Service will endeavor to assemble and release annually such information in condensed form. It is therefore suggested that there be sent, before June 1, to the Fish and Wildlife Service, U. S. Department of the Interior, Washington, D. C., titles of research in progress with the year of probable completion and the name and address.

DR. CHARLES H. BROWN, librarian of Iowa State College and president of the American Library Association, announces that American libraries will be allowed to purchase $250,000 worth of scientific and technical books and magazines from Nazi-controlled Europe. The United States Government, working through the joint committee on importations, which represents seven national library associations, will allow purchase of technical material vital to the war effort. Both the American and the British Governments have agreed to the purchases by the library committee.

DATA compiled by the Council on Dental Education of the American Dental Association show that in 1933–34 there were 38.3 per cent. of students entering dental schools with less than two years of college preparation, 35.6 per cent. with two years and 26.1 per cent. with three or more years. In 1939–40, all the 39 dental schools of the United States reached a

uniform requirement of two years of college work before entering the dental course. As a result the data for 1941 show no entering students with less than two years, 53 per cent. with two years and 47 per cent. with more than two years of college training. Almost half of the entering students in 1939–40 have educational qualifications beyond the minimum recommended in 1935 by the Curriculum Survey Committee of the American Association of Dental Schools (two years) and in excess of the two-year requirement of the Council on Dental Education of the American Dental Association as announced for the year 1941–42.

UNDER the Australian federal system, public education is a function of the state governments, and the six universities look to these bodies for financial support. Five years ago, however, the Commonwealth Government undertook a share of this responsibility by providing £30,000 a year to meet costs of research in the natural sciences and in economics, and of training young graduates in research technique. The funds are administered by the Council for Scientific and Industrial Research in consultation with the Vice-chancellors' Conference. The Commonwealth has now announced, according to *Nature,* its intention to raise its contribution to £40,000 a year, beginning this year, on condition that at least £9,000 a year be devoted to social science studies bearing on problems of post-war reconstruction.

ACCORDING to *Nature* a new step in the rationalization of the British fine chemical industry has been taken by the formation of the Therapeutic Research Corporation of Great Britain, Ltd., the directors of which are Lord Trent, of Boots Pure Drug Company, Ltd.; C. A. Hill, of the British Drug Houses, Ltd.; H. Jephcott, of Glaxo Laboratories, Ltd.; T. B. Maxwell, of May and Baker, Ltd.; and T. R. G. Bennett, of the Wellcome Foundation, Ltd. Although each of the directors of the new corporation is managing director of his own concern, it is not an amalgamation of these five firms. Each will retain its freedom of action in its special field, but will contribute to the common research pool; in effect, a much extended research team now becomes available for work on new drugs, and overlapping effort should be eliminated. It is also hoped to secure the interest and cooperation of research workers in academic institutions. The corporation will have at its command in the various chemical, physiological and bacteriological laboratories the choice of many different lines of approach to its problems and the call on the extensive scientific personnel and equipment of the five companies which are collaborating.

DISCUSSION

A GROUP THEORY DILEMMA OF SOPHUS LIE AND FELIX KLEIN

THE study of group theory as an autonomous subject began with the development of the theory of permutation groups which were then more commonly called substitution groups and are still sometimes denoted by this name. This development was mainly actuated by the usefulness of these groups in the study of the theory of equations as is indicated by the title of the first book on group theory, viz., "Traité des substitutions et des équations algébriques," by M. Camille Jordan (1870). Since the only non-intrinsic condition which a set of distinct permutations must satisfy in order to be a group is that it contains the product of every two and the square of every one in the set it resulted that many people at first assumed that this is the only condition which an arbitrary set of distinct elements must satisfy in order to be a group. This assumption was supported by the fact that many other sets of well-known elements which satisfy this condition intrinsically satisfy the other necessary conditions in order to be a group in the modern sense of this term.

This circumstance throws light on various early remarks relating to group theory and, in particular, on what we call here a group theory dilemma of Sophus Lie and Felix Klein, two of the most widely known names in the history of group theory as well as in the history of modern mathematics. On page 163 of volume 1 (1888) of his work entitled "Theorie der Transformationsgruppen," in three large volumes, Sophus Lie (1842–1899) said that the transformations $x' = ax$, where the absolute value of a is less than unity, constitute a group which contains neither the identity nor the inverse of any one of its elements. It is clear that the same conclusions might have been reached for similar reasons by assuming that the absolute value of the number a in the given transformations is always greater than unity since these transformations also include the product of every two of them irrespective of whether they are equal or unequal.

As definite evidence of the common inadequate notion of group at that time from the modern standpoint it may be noted that about five years later Felix Klein (1849–1925) stated on page 66 of volume 43 of the *Mathematische Annalen,* of which he was then editor, that Sophus Lie had first pointed out that for groups of infinite order it was not a consequence of the group concept that the inverse of each element of a group appears in the group. He acknowledged then that in his now well-known Erlangen Programm (1872) he tacitly made this assumption but that it should have been explicitly stated as a part of the particular groups then considered by him. It is a very interesting fact in the history of group theory that less than

fifty years ago there was still such a wide-spread lack of clarity as regards the notion of group on the part of some of the most eminent mathematicians of the day. The same volume which contains the mentioned remarks by Felix Klein contains also the modern postulates with respect to an abstract group by H. Weber (1842–1913) so that darkness and light relating to this concept are here closely associated.

Neither Sophus Lie nor Felix Klein ever adopted the modern postulates for an abstract group in their writings and in volume 1 (1926), page 335, of his "Vorlesungen über die Entwicklung der Mathematik" the latter remarked that the definition of group based on such postulates is very well suited for instruction and for a clear development of the subject but not for the discovery of new ideas and new methods. He stated on the same page that both he and Sophus Lie in their early work in group theory assumed only that the product of every two of a given set of elements is in the set in order that the set is a group but that Sophus Lie found it necessary in his later work to explicitly assume also that the set includes the inverse of each of its elements as a part of the definition of the term group.

On the contrary, the group theory postulates of H. Weber, or their equivalents, were at once taken very seriously in America, largely on account of the very successful works on algebra which he published and which contain these postulates. Various attempts were made in America to obtain more useful sets of postulates. As regards group theory these efforts were conducive to caution so that the laws or commandments as regards the concept of group were not transgressed but they did not lead to any great advances within the subject itself. The dilemma of Sophus Lie and Felix Klein to which we referred above was due to the fact that in their early work they had tacitly assumed that it is unnecessary to restrict the group concept to sets of elements which always include the inverse of each element but that they later abandoned this idea.

It is questionable whether any publication contributed more than Felix Klein's Erlangen Programm towards making the subject of group theory widely known and highly appreciated. It was translated into Italian (1890), into French (1891), into English (1893), into Polish (1895), into Russian (1896) and into Hungarian (1897). Nevertheless, according to Felix Klein's own statement it contains an inadequate definition of the group concept but one which includes its most effective elements. Those who later refined this definition also made valuable contributions towards the advancement of this subject, but their work naturally received less extensive attention. Great mathematical progress was frequently made by those who failed to observe pitfalls which their successors carefully labeled and which too frequently engrossed their attention.

G. A. MILLER

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PENTHESTES AND CALOPHYA

THAT black-capped chickadees are making a substantial part of their winter diet on "jumping plant-lice" along the Connecticut shore may interest zoologists; that the psyllids are found upon sumac may interest botanists; and that *Calophya flavida* in its present nymphal stage abounds on *Rhus glabra*, while *Calophya nigripennis* abounds on *Rhus copallina* may interest ecologists. The two species of sumac, growing in close admixture, carry only their proper species of psyllid, never the other one. Dr. Oman, who determined the psyllids for me, informs me that only these two species of *Calophya* are known to occur in eastern United States.

Early this winter, 1941–42, I observed chickadees feeding freely on the very abundant sumacs of this region, interested not only in the fruit clusters but also picking minute objects from the stems of these shrubs, both low down near the ground and higher up. With field-glasses permitting very close-up work I saw that they took these from areas surrounding leaf-buds also from areas close to forks in the branches primarily. With a hand lens I examined the areas the birds had just worked, and found plenty of the beautifully sculptured nymphs. Those of *C. flavida* are darker and larger and have more marginal setae than nymphs of *C. nigripennis*. The numbers of both species are diminishing, under the attacks of the chickadee, as winter progresses. The birds are also feeding on many other animal and plant foods. Had their stomach contents been examined the nymphs might never have been recognized and determined except as pulp of animal origin.

RALPH E. DANFORTH

NOANK, CONN.

DEGREES AT ANY TIME: BRAIN CONSERVATION

IN a recent number of SCIENCE[1] the writer discussed the importance of a twelve-month college year to insure earlier completion of curricular requirements. This was prompted by the frequently expressed desire in various quarters that students have the opportunity to complete their collegiate education before reaching draft age. It was pointed out that the plan was desirable not only in war-time, but that it was a good peace-time idea. Just as the article on the twelve-month college year was a long postponed sequel to a post-World War I article,[2] so the present discussion

[1] A. Silverman, SCIENCE, 95: 192, 1942.

a sequel to an earlier article.[3] While the nation is in need of specially trained men of all capacities, it particularly wants the service of leaders and thoroughly dependable workers. Whether continuous instruction is afforded through the twelve-month college year or we follow the traditional custom of granting a long summer vacation, it seems desirable to get away from educational policies which serve only the average student. At present most institutions expect students to graduate in four years. A few get through sooner by taking summer courses. There are superior students who might cover a required curriculum in a much shorter time. There are others who can not keep the average pace, and they fail. In the earlier article to which reference was made[3] the writer likens students to automobiles, asking whether one thousand automobiles starting from New York at a given moment could all be expected to arrive at San Francisco at the same time even if they were the same model of a given make. Failure of mechanical devices to accomplish uniform service suggests that human beings, whose variations are greater than those of machines, should hardly be expected uniformly to follow a schedule. The writer feels that many superior students, who are retarded by the average pace of their fellow students, lose ambition and slow up their efforts. Also, there is no doubt that the student who can not go the average pace often gives up hope and fails.

While the educational facilities and financial status of our colleges and universities will, in the majority of cases, not permit the plan which is proposed, it is worth looking forward to. Assuming an adequate and competent instructional staff, good library facilities and sufficient laboratory space, a student would be permitted to follow a plan or a curriculum under direction or guidance, but chiefly through self-education in the library and laboratory, to advance himself as rapidly as possible. The instructor should be available when the student requires conferences. Regularly scheduled lectures would be abandoned, and except for occasional inspirational lectures, the student would have to depend on himself and on conference guidance. No text-books would be assigned, but good texts and reading references might be suggested. Grades would be abolished, and the only criterion would be the satisfactory completion of the work done. When the courses required in a given plan or curriculum have been completed satisfactorily, instructors would certify students to the institution's registrar, and a degree could be conferred at this time. If the work has been done in a year and a half or two years, the student can either go on with graduate study or go into service—commercial, educational, governmental. The student who requires more than four years, in other words is slower than average, can go on for five or even six if necessary, and by that time satisfactorily complete his requirements instead of having failed and been deprived of a degree at the end of four years. He would deserve receiving one after all. Naturally there will be students who are incompetent. After a given time these could be asked to vacate in favor of the deserving. Each student who has satisfactorily completed the requirements for a degree is entitled to it. The majority may still require four years. Instead of "getting by" in some courses as students do at present, they complete every course satisfactorily. They are not dependent on lectures from professors and daily guidance by them, but become self-reliant. They do not walk on the crutches of the predominating educational system of our day, but possess self-confidence. The student's independent search of the literature and independent exploration of the laboratory technique develop an assurance which regularly scheduled and constant direction do not afford.

Advocates of the grading system and the appraisal of individuals on this basis might hesitate to abandon the idea of "quality in a fixed time" for "satisfactory performance in variable time periods." It is the writer's recollection that the psychologist considers satisfaction the result of successful accomplishment, and happiness dependent upon satisfaction. With this in mind the superior student or man of genius, the average student and the slow worker, all succeeding in their tasks, performing satisfactorily, could be happy in their own way instead of experiencing the anxiety which the present system must bring to many students.

The instructor, through personal contacts with individual students and the direction of their efforts, could readily ascertain whether a student's performance is satisfactory. Examinations could be given at intervals if necessary or a student might be subjected to comprehensive examination upon completion of a subject or group of courses. The student would be sent into the world of affairs as a rapid, keen thinker or worker, an average individual or as a slow but steady and dependable one. In any event he can render satisfactory service at the pace which he can go, and the world would have its genius encouraged and cultivated, its average man and its plodding but reliable servant. It would not be getting a ninety per center or an eighty per center or a seventy per center from the standpoint of quality of work done. All work would be of one hundred per cent. quality and the service would be rapid or slow, as certified when the individual graduates. Genius would not be curbed. The slow worker and average worker, learn-

[2] *Idem, School and Society,* 12: 80, 1920.
[3] *Idem, Industrial and Engineering Chemistry,* 16: 860, 1924.

ing how properly to master a task, could improve their pace gradually. We would conserve the most precious possession of man, the human brain.

All this would cost money. We would need larger libraries, larger faculties, more laboratories. Each student would want space where he could work at any time day or night. He would want a competent advisory force to afford him conferences when required. The investment should prove worth-while. Just now, we are particularly anxious to eliminate slipshod and irresponsible performance. We need dependable individuals and good performance. After World War II is won and we are accustomed to heavy taxes, we can devote a portion of the funds collected to "brain conservation."

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QUOTATIONS

THE A.A.A.S. BULLETIN[1]

EVERY member of the American Association for the Advancement of Science will receive each month a new publication, of which this is the first issue. No formal subscription for it will be required of members of the association, for its cost to them is included in their annual dues.

Broadly speaking, the purpose of the *A.A.A.S. Bulletin* is to advance science which, of course, is the purpose of all the activities of the association. But the advancement of science has a continually expanding and changing meaning. When the association was founded science was classified largely as "natural philosophy" and "natural history." Since that time science has been divided and subdivided into numerous special fields. There are now more than a thousand scientific organizations in the United States and Canada.

With the expansion of science the needs for increasing avenues of publication have led to the establishment of many special scientific journals. There has not been, however, corresponding increases in the number of journals for science in general, nor have those in existence been able to increase appreciably, if at all, the number of pages they print per year. This has been true of *Nature,* SCIENCE and *The Scientific American.* Obviously the needs of the association for journals are much greater than they were thirty or forty years ago when it held only one meeting each year and had no divisions and fewer than half as many affiliated societies, and when its membership was only a fraction of its membership to-day.

As science becomes more and more specialized, it becomes increasingly important to maintain interconnections among its various fields. That this fact is realized by specialists in the fields of the natural sciences is proved by the numerous joint symposia of sections and societies that have been held at the meetings of the association. But to specialists in these fields the social sciences, generally speaking, have been regarded until recently as being in foreign lands. It has taken the shocks of war to teach men the now obvious fact that human beings are so interdependent that no group can isolate itself from the remainder even on the lofty peaks of pure science. The association, with its sections in the fields of both the natural and the social sciences and with its many affiliated societies from both fields, is ideally constituted to furnish opportunities for exploring the interrelations of science and society.

Several times in the past scientists have largely failed to recognize the tides in human affairs which they themselves have created. For example, when Charles Darwin removed man from his lonely and barren pedestal of a special creation, his contemporaries did not realize that he had ascribed to man all the rich qualities that flow in the varied stream of life and all its possibilities for change. Now when the applications of science have removed all the physical barriers that have hitherto separated peoples from peoples, let not the fact escape scientists that they have opened the gates to both Paradise and Purgatory. Which shall be humanity's fate now depends in large measure upon the ideals with which they inspire the world.

In order that the association may function more effectively as an integrating agency for science and society during the war, after its close, and indefinitely in the future, this publication has been established by the executive committee. It enables the office of the permanent secretary to communicate directly with all the members of the association. This has been impossible, except by mail, because about sixty per cent. of the members receive SCIENCE and about forty per cent. *The Scientific Monthly.* Moreover, not many of the announcements that will appear in this bulletin will be appropriate for SCIENCE and none of them for *The Scientific Monthly,* both of which will continue to occupy the distinguished positions in American science that they have long held in the past. The

[1] Introduction to the first issue, March, 1942, published monthly by the American Association for the Advancement of Science. The Office of Publication is at North Queen St. and McGovern Ave., Lancaster, Pa. The Editorial Office is in the Smithsonian Institution Building, Washington, D. C. The names of the editors are not given.

new publication will supplement them and provide a new medium through which the affiliated societies may make announcements of their programs and of their undertakings of general interest.

There is a labor and financial aspect of the establishment of this publication which merits a few comments. To send out through the mails a communication from the office of the permanent secretary to all the nearly 24,000 members of the association is so costly in labor and money that there is always pressure to refrain from doing so. Many of these desirable communications will appear substantially in this publication at much less cost. As a matter of fact, taking all the items of labor, envelopes, paper and postage into account, the cheapest mail service hitherto available to the association for communication to all members is about eight times as costly as through this *A.A.A.S Bulletin*.—THE EDITORS.

SCIENTIFIC BOOKS

OIL FIELDS

Stratigraphic Type Oil Fields. A Symposium. A. I. LEVORSEN, editor. xii + 902 pp. Illustrated. Tulsa, Okla.: American Association of Petroleum Geologists. $5.50 ($4.50, members).

PETROLEUM geologists have long construed their task as primarily a search for structure in known or prospective oil-bearing regions. They have been prone to think of oil reservoirs as the product of deformative geological processes. With the rapid accumulation during recent years of descriptive literature of numerous oil fields, it has been increasingly evident that many effectively sealed reservoirs are not the sole product of deformation. Many are primarily lenticular sand bodies, favorably interleaved in oil-bearing horizons or occurring on planes of unconformities. Some are the result of variable porosity and permeability in either limestones or sands; others are due to pinch-out up-dip of sand horizons or to the erosional truncation of sands, subsequently overlapped by an impervious cover. The East Texas field, the largest ever discovered, is thought to belong in the latter category.

Though the true character of many such reservoirs had previously been appreciated, the discovery of the East Texas field brought sharply into focus the importance of the so-called stratigraphic trap in our search for new fields. It aroused anew the suspicion that the discovery of a large reserve of oil contained in such traps awaited the evolution of a better geological technique, capable of coping with this more difficult problem. Areal and subsurface geology, geophysical exploration based on seismic or gravity determinations—all are designed chiefly to decipher structural conditions and often fall short of offering clues to the presence of stratigraphic traps.

The present volume includes descriptions of thirty-seven oil and gas fields situated in the various producing districts of the United States which illustrate the types of stratigraphic traps mentioned above. It presents factual data which should be useful in the further search for pools of this type. "New principles of future oil discovery depend to a large extent on an understanding of past experience. . . . The present volume . . . is intended as a factual background on which a further approach may be made to the causes of oil and gas accumulation and also as a basis for the reasoning necessary to future oil-field discovery" (Foreword).

The large majority of the papers deal with the vagaries of sand deposition which result in clear-cut examples of stratigraphic traps. Of especial interest are those which reconstruct paleogeographic conditions to show that the sand bodies were deposited as off-shore bars, channel filling or other familiar shoreline phenomena.

Obviously sedimentation is the controlling geological factor throughout this symposium. The volume should therefore prove most useful as a reference work in this field. Another very useful feature is the extensive annotated bibliography including 227 references to papers dealing with the same subject matter in recent geological literature.

W. E. WRATHER

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ORGANIC CHEMISTRY

Identification of Pure Organic Compounds. Tables of Data on Selected Compounds of Order I. By E. H. HUNTRESS and S. P. MULLIKEN. xvii + 691 pp. New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd. 1941. $7.50.

ORDER I consists of compounds of carbon with hydrogen, or with hydrogen and oxygen. In this respect it resembles Volume I of Mulliken's four-volume work of the same title, which appeared in 1904. The general purpose, plan and function of the two, as well as the basis of primary classification, are similar. In other respects, however, they are quite different, so that this new compilation is not at all a new edition or revision of the earlier and well-known "Mulliken," but is an original contribution.

It differs from "A Manual for the Systematic Identification of Organic Compounds," by the same authors, which has appeared in mimeographed or

planographed editions, and which it supplements, in that its serviceability is not dependent upon any one particular scheme of analysis. No matter what the analytical approach may be, these tables will be found useful not only to students of organic qualitative analysis, but also to all chemists concerned with the identification of unknown organic compounds. The publication appears opportunely, for many changes have occurred in such data since 1904, and a complete set of "Mulliken" has been unobtainable for many years.

Following an explanatory introduction (14 pp.), and a description of the Generic Tests of Order I (11 pp.), the succeeding chapters are devoted to Aldehydes (50 pp.); Carbohydrates (7 pp.); Acids (116 pp.); Phenols (71 pp.); Esters (75 pp.); Acid Anhydrides and Lactones (4 pp.); Ketones (43 pp.); Alcohols (83 pp.); Ethers, Hydrocarbons, etc. (120 pp.); Colored Compounds of Order I (Suborder II) (25 pp.); and 26 pp. of valuable Tables of Melting Points of Series of Derivatives of Compounds of Order I commonly used for identification purposes. An Index of Compounds according to Empirical Formula and a general Alphabetical Index of Compounds of Order I conclude the volume. In addition to these two indexes, seven of the nine genera comprising the book are immediately preceded by a separate alphabetical name index and an index of chemical types. As noted above, the "Tables of Melting Points of Series of Derivatives" constitute another index.

The introductory chapter sets forth the system used for the classification of compounds, a brief synopsis of the general procedure for identification of unknowns, the arrangement of the data on individual compounds and the nomenclature adopted. Extensive use is made of abbreviations, as is essential in a reference work of this character, to economize space and to keep down the cost.

One of the difficult problems in all discussions or tabulations of "selected" organic compounds is to decide which compounds to select from the hundreds of thousands already in the literature. In his choice of the 1,364 compounds described in the present volume, the author has restricted his list, in most cases, to compounds which are commercially available or which can be prepared readily from accessible materials.

In compiling the tables, the literature has been searched carefully and laboriously, particularly for the years 1920–1940, about 70 per cent. of the approximately 7,500 citations recorded falling within that period. Every compound described also carries its Beilstein reference.

The book is an indispensable adjunct to all laboratories where the identification of organic compounds is a matter of interest or importance. Paper, press work and binding are excellent.

Micromethods of Quantitative Organic Elementary Analysis. Second edition. By JOSEPH B. NIEDERL and VICTOR NIEDERL. xiii + 347 pp. New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd. 1942. $3.50.

THE scope of the original edition has been somewhat enlarged, while retaining the same mode of presentation. New developments, improvements and simplifications, as well as the latest important contributions, have been included. "Remarks" and "Literature" are deferred until the conclusion of the chapters, so as not to interrupt descriptions of the analytical procedures.

Organic Syntheses. Collective Volume I. Second revised edition. Edited by HENRY GILMAN. Revised by A. H. BLATT. xi + 580 pp. New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd. 1941. 6.00.

THIS follows exactly the plan of the first edition and, like it, includes all the preparations given in Volumes I to X inclusive of "Organic Syntheses." For a number of these preparations, new or improved procedures have been added. Errors have been corrected. The literature has been reviewed through *Chemical Abstracts* for 1940 (vol. 34), and to each preparation a sub-title has been supplied, giving the C. A. indexing name wherever that differs from the one used in the heading.

An Introduction to Organic Chemistry. Fourth edition. By ROGER J. WILLIAMS. xi + 628 pp. New York: D. Van Nostrand Co., Inc. June, 1941. $4.00.

SINCE the publication of the third edition of this excellent textbook in May, 1935, developments in the rapidly changing field with which it deals have necessitated this revision, to bring it up to date, while the general arrangement and method of treatment remain the same.

MARSTON T. BOGERT

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A BIBLIOGRAPHY OF PRIMATES

Bibliographia Primatologica—A Classified Bibliography of Primates Other than Man. By THEODORE C. RUCH. 241 + xxvii pages. Baltimore: Charles C Thomas. 1941. $8.50.

THIS is publication Number 4 of the historical laboratory of Yale Medical Library, and is Part I of a projected bibliography on primates. Part II will involve pathology and taxonomy. The headings used are embryology, general morphology, circulatory and

lymphatic systems, respiratory system, digestive system, the endocrine glands, urogenital system, osteology, arthrology and syndesmology, teeth, muscular system and integument, nervous system and sense organs. Physiology and pharmacology: blood and circulation—respiration, digestion nutrition and metabolism, kidney and water balance, endocrine glands, animal heat, reproduction and development, muscles and skin, nervous system and sense organs, pharmacology. Psychobiology: receptive capacities, the action system, maturation of behavior, motivation of behavior, modifiability of behavior, intelligence and behavior—insight—ideation, reproductive and social behavior, miscellaneous, observational psychobiology.

There are 4,630 entries, a list of miscellaneous bibliographies and an index of authors' names of 27 pages. The book is a beautifully prepared volume of double column format, with bold-faced headings to each entry, which makes it easy of consultation. Classification is largely by subject, with items arranged by author, but in the case of literature up to the nineteenth century it is chronological. Where an entry covers two subjects it is entered under the principal one and cross indexed under the other. The effort is always to make the bibliography practical. Thus under "Habits in Nature and Captivity" the classification is taxonomic, the author believing that "Whatever the initial zeal, the discomforts of Procrustean categories soon convinced us of the folly of attempting to divide a literature where definite lines of cleavage do not exist."

Separate publications are distinguished by having the titles printed in italics. The use of capital letters is reduced to a minimum. Total pagination is given in every case. In order to make the reference as exact as possible, a system of markings is adopted which indicates the extent to which an article presents primate material. As a further means to exact determination the character of the publication is indicated—abstract, review, lecture, etc. Finally the name of the animals treated is given in abbreviation.

C. E. McCLUNG

SPECIAL ARTICLES

OBSERVATIONS ON AN EPIDEMIC OF POLIOMYELITIS[1]

AN epidemic of poliomyelitis was observed in which the transmission of the disease seemed largely limited to the late incubation and early prodromal periods, and the spread from neighborhood to neighborhood and community to community greatly influenced by human travel. The place was Walker County (population 65,000), a mountainous and mining region in north central Alabama. The epidemic began in the last week in June, reached a peak early in August, and was virtually ended by the last week in September, 1941.

Along with controlled studies of certain age groups the families of 101 of the 121 reported cases of all ages were interviewed between August 8 and November 8 in a systematic manner by the same investigator, and in 91 instances most of the families of neighbors, friends and reported contacts of the case. Unreported cases of poliomyelitis were uncovered, and many acute febrile illnesses compatible in the broadest sense with abortive poliomyelitis. No epidemic of any disease except poliomyelitis was recognized in the areas between June 15 and September 15, and the isolated cases of mumps, measles, pertussis, etc., did not exceed 10 per cent. of the frank poliomyelitis cases observed. Of the 101 individuals studied 87 had paralytic and 13 abortive poliomyelitis with myelitic or meningitic signs, and one had an acute febrile illness compatible with abortive poliomyelitis (in a like twin whose brother had paralytic poliomyelitis); five died; 85 were under six years of age.[2]

Although the residences of many of the 101 patients were among the most isolated in the eastern United States, not one patient had been isolated during the month preceding the illness. Visits were generally among relatives or church workers (the contact was frequently at the premises of a neighbor of the family visited). Of the 101 patients 81 had experienced within 34 days of onset prolonged direct contact with a prior acute febrile illness compatible with poliomyelitis (in 67 instances it was frank poliomyelitis, 38 of which had been reported and 29 unreported; 5 of the remaining 14 children had in turn been exposed 4 to 18 days prior to onset to frank poliomyelitis, and 6 others resided in or had visited an epidemic neighborhood in the same period). In 72 of the 81 instances the children played together for more than an hour, the least interval being a child's "ten minutes"; in perhaps every instance a portion of the visit was in the daytime; in many it was limited to this period and to the premises outside of the house.

In 45 instances the contact with prior poliomyelitis

[1] The work was supported by the National Foundation for Infantile Paralysis and the Alabama Department of Public Health.

[2] Valued assistance in the clinical study of this epidemic was received from Dr. A. M. Waldrop and staff of the Walker County Health Department; Dr. B. M. Beach, associate director of child hygiene, Alabama Department of Public Health; Dr. Earle Conwell and staff of the State Crippled Children's Bureau; Dr. A. G. Gilliam, U. S. Public Health Service; and Drs. J. D. Trask, J. R. Paul and H. A. Wenner, Yale University School of Medicine.

was multiple, frequently because of small mining camps with numerous pre-school children in daily communication with each other (most of whom developed an acute febrile illness after exposure to poliomyelitis). The virus of poliomyelitis was recovered from flies trapped near a privy used by families of four acute cases in such a camp.[3] In 37 instances of multiple contact the children lived within 300 yards of each other.

In 36 instances the contact with prior poliomyelitis was single, and took place in 30 (83 per cent.) before the contacted child or the victim became ill. In 18 of the 30 it occurred on the day of onset and in the remainder during the 3 days before the onset of the prodromal period in the contacted child. Among the 30 single contacts on or before the day of onset 16 of the visits were made by the child about to become ill (average distance covered was 7 miles) and 14 by the victim (average distance covered was 10 miles). The group represented for the most part the first cases in their respective neighborhoods and the most severe instances of poliomyelitis in the epidemic. Four of the 5 deaths among the 121 reported cases (and the only death among the unreported prior contacts) were in this 30; in 27 instances both contacted child and victim developed paralytic or myelitic poliomyelitis. For the 30 victims there were 20 different places of contact (and 20 different contacted children) separated by an average distance of 4.5 miles from the nearest prior poliomyelitis, reported or unreported. The prodromal period in the 30 victims began 3 to 21 days after the exposure to the contacted child (the average incubation period was 12.3 days) (Fig. 1).

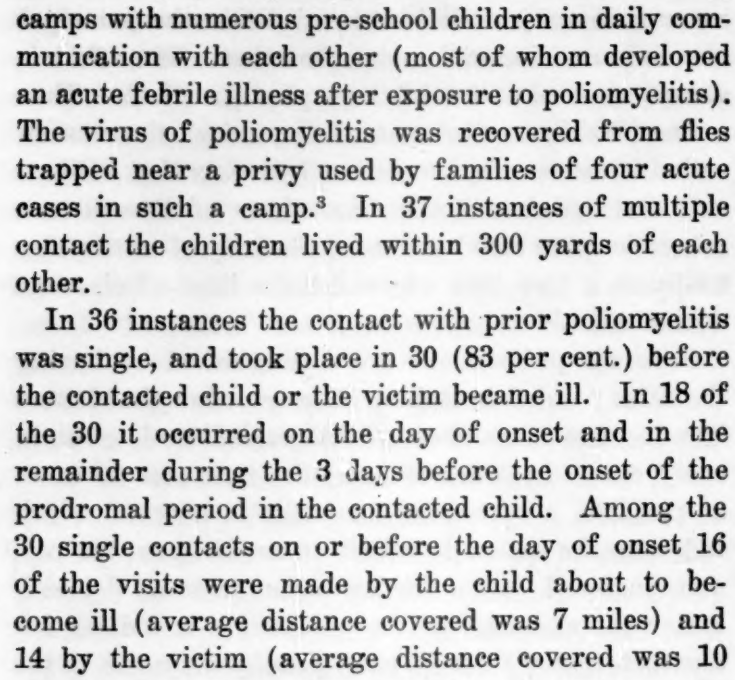

FIG. 1.

It was improbable that infected insects or other agents[3, 4, 5] traveled the average distance of seven miles and selected the same 16 victims out of a pre-school child population of over 3,000 as were visited by the 16 incipient poliomyelitis patients. If a mobile human reservoir was responsible in the 16 instances where the about-to-be-ill child did the visiting, it was equally true in the reverse, since only 14 instances were recorded of the victim visiting the incipient patient under the same circumstances. The mobile human reservoir was also a transient one, since half of the children who developed the disease visited with the patient on the day of onset (in the 36 instances where there was a single visit). It was unlikely that 50 of each clinically non-infected visitors who came from distant neighborhoods would do so on the day of onset in the incipient patient. How the virus was spread from one child to the other was not attacked in the study. The premise of insect transmission to be compatible with the present findings would require the insect to have acquired the virus from the blood, secretions or excreta of an incipient poliomyelitis patient and to have transferred it within 24 to 72 hours to a second child generally on or near the premises where the visit took place. For the premise of direct transmission of the virus from the secretions or excreta of one child to the nose, eye or mouth of the other the histories are also compatible.

Summary and Conclusions: An epidemic of poliomyelitis was observed in which human travel was a major factor in the spread of the disease from neighborhood to neighborhood and from person to person. Eighty per cent. of the poliomyelitis patients had probably visited or been visited by a prior poliomyelitis patient who was in the late incubation or early prodromal period. The effective reservoir of the virus was seemingly a patient within three days before or three days after the onset of the first prodromal symptom. Whether the effective virus was present in the blood, the secretions or the excreta of the patient at this critical period and how the transfer was accomplished was not determined.

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THE INTRAVENOUS DRIP AND OTHER INTENSIVE METHODS FOR THE TREATMENT OF EARLY SYPHILIS[1]

THE finding[2] that early syphilis may be effectively treated, and in most cases definitively cured, within 5

[3] J. R. Paul, J. D. Trask, M. B. Bishop, J. L. Melnick and A. E. Casey, SCIENCE, 94: 395, 1941.

[4] A. B. Sabin and R. Ward, SCIENCE, 94: 590, 1941.

[5] J. A. Toomey, W. S. Takacs and L. A. Tischer, *Proc. Soc. Exp. Biol.*, 48: 637, 1941.

[1] From the U. S. Public Health Service, Washington, D. C., and the Syphilis Division of the Department of Medicine, the Johns Hopkins Medical School, Baltimore, Md.

[2] George Baehr, William Leifer, Louis Chargin, H. T. Hyman, *et al.*, *Arch. Derm. and Syph.*, 42: 239, 1940.

days by administering neoarsphenamine or Mapharsen in an intravenous drip, is of obvious importance both to the individual patient and to the current control program. This intensive procedure is, however, many times more dangerous than standard clinic practice.[3] Whether this increased risk is justified by the somewhat more rapid control of infectiousness, and by the perhaps more favorable early results achieved by the intravenous drip as compared with average clinic practice, is debatable. Nevertheless, it seems clear that the traditional schedule of weekly injections for 18 months, however effective and however safe, is wholly arbitrary. Given as three variables, (*a*) the total duration of treatment, (*b*) the number of injections and (*c*) the size of the individual dose, there are obviously an infinite number of possible combinations. Given further the fact that a 5-day and an 18-month schedule may be of comparable therapeutic efficacy, it should be possible, with the same drugs, to find effective methods of treatment which combine the speed of one and the safety of the other to an optimum degree.

Because of the very number of possible combinations of time and dose and because of the difficulties inherent in any clinical evaluation, the initial problem of orientation seemed clearly one for the laboratory rather than the clinic.

Accordingly, in the fall of 1939, we undertook to determine in syphilitic rabbits the toxicity and the therapeutic activity of twelve different treatment schedules, embracing wide variations in the frequency and duration of treatment. Mapharsen (3-amino-4-hydroxy phenylarsine oxide) was used throughout. The twelve experimental treatment schedules were as follows:

Intravenous drip (5 and 6 hours daily) for 1, 2 and 4 days.
Multiple injections each day for 1, 2 and 4 days.
Single daily injections for 1, 4 and 12 days.
Injections every other day (3 times weekly) for 4 and 8 weeks.
Weekly injections for 6 weeks.

A total of 2,000 animals has been used to date. Although the study is not yet completed, the results are sufficiently clear-cut to justify certain generalizations, presented at this time because of their implications with respect to the present-day treatment of early syphilis.

A. Therapeutic Efficacy

Within broad limits, the curative dose of Mapharsen with any one type of treatment was largely independent of the time period over which that treatment was given. Indeed, in seven schedules involving rapid intravenous injections, in which the total duration of treatment varied from 10 seconds to 6 weeks, the interval between injections from 2 hours to 1 week, and the total number of injections from 1 to 16, the minimal curative dose[4] varied only between 4 and 8 mg per kg. Although there was some suggestion that repeated doses at short intervals were more effective than either one large dose, or repeated doses at weekly intervals, the data are as yet inconclusive.

The minimal curative dose of the intravenous drip procedure, whether for one day or for four days, varied only between 7 to 12 mg per kg. It is of interest to note that Mapharsen administered by intravenous drip has been consistently less effective than Mapharsen administered by repeated injections over the same time period.

B. Toxicity

Of primary importance is the fact that, on every treatment schedule yet tried, the total amount of arsenical which could be administered without killing the animal increased directly with the total duration of treatment. Of secondary importance is the fact that, within a fixed time period, somewhat larger amounts of arsenical could be administered by increasing the frequency of injections. Thus, on daily injections for 4 days, the maximal tolerated dose was 30 mg per kg. This was increased to 40 mg per kg by giving 4 injections daily over the same time period, and to 48 mg per kg by giving a continuous intravenous drip for six hours daily on each of four consecutive days.

This apparent advantage of the short-term intravenous drip with respect to toxicity is, however, illusory on two scores. In the first place, Mapharsen given by intravenous drip is apparently less effective than the same amount of arsenical given by simple intravenous injection. More important, since the total tolerated dose of arsenical given by simple injection can apparently be increased almost without limit merely by prolonging the duration of treatment, it is possible to administer far larger amounts of arsenical with greater safety by injections repeated daily, every other day or weekly, over a sufficient period of time.

C. Margin of Safety ("Chemotherapeutic Index")

Since the total curative dose of Mapharsen in rabbits is, within broad limits, approximately constant, and since the total tolerated dose on any schedule of injections increases directly with the duration of treatment, it necessarily follows that *the margin of safety*

[3] David C. Elliott, George Baehr, Loren W. Shaffer, Glenn S. Usher and S. Allan Lough, *Jour. Am. Med. Assn.*, 117: 1160, 1941.

[4] The dose which cures more than 95 per cent. of the animals, as shown by negative lymph node transfers 6 weeks and again at 6 months after treatment.

between the toxic and therapeutic dose ("chemotherapeutic index") may be increased continuously by prolonging the duration of treatment. Conversely, on any schedule of injections, the shorter the total time period over which the treatment is administered, the lower is the margin of safety afforded.

Thus, (1) on six weekly injections the total tolerated dose (60 mg per kg) was 7.5 times the minimal curative dose (8 mg per kg), as compared with a margin of 1.4 for a single injection. Moreover, the margin of safety afforded by 30 weekly injections would probably be not far from 30. (2) When the injections were given three times weekly for four weeks, the chemotherapeutic index was 12: and it is estimated that the index on a similar eight-week schedule would be about 24. (3) With four consecutive daily injections, the margin of safety was approximately 6; and it is estimated that 12 daily injections will provide a margin of approximately 10. (4) Multiple daily injections over a four-day period gave a safety factor of approximately 10; and an intravenous drip for the same period provided a margin of safety of only 4. In both cases, a shorter time period (1 or 2 days' treatment) gave an even lower chemotherapeutic index; while a longer treatment period would presumably have resulted in a correspondingly wider margin of safety.

D. Clinical Implications

In the absence of evidence to the contrary, we must assume that these same considerations apply in human beings. Indeed, such data as are available from the clinic are in accord with the dual thesis that the total curative dose of Mapharsen varies only slightly with the frequency and total duration of treatment, while the total tolerated dose varies directly with the time period over which the arsenical is administered.

The implications with respect to the treatment of human syphilis are clear. On any schedule of injections, any desired margin of safety can apparently be achieved by suitable prolongation of the treatment period. Some compromise between the vexatious 18-month schedule, as now employed, and the dangerous 5-day schedule is clearly possible. Current clinic practice calls for approximately 40 injections of 60 mg each of Mapharsen and 40 injections of bismuth over an 18-month period. If we omit from consideration the role of bismuth, which is probably of secondary importance as compared with the arsenical, and if we take due cognizance of the fact that relatively few patients in the average clinic actually complete this treatment schedule, the desideratum appears to be an intensive treatment schedule as effective as 20 to 30 weekly injections of 60 mg (1 mg per kg) Mapharsen, and providing a comparable margin of safety.

On the basis of our animal results to date, those requirements would be at least approximated by (*a*) injections of 20 mg Mapharsen (0.3 mg per kg) repeated twice daily for 4 to 8 weeks; (*b*), daily injections of 30 mg Mapharsen (0.5 mg per kg), continued for 5 to 10 weeks; or (*c*), injections of 60 mg Mapharsen (1 mg per kg) repeated three times weekly for 5 to 10 weeks. Probably dozens of schedules could be elaborated, both safe and effective, the only choice between which would be that of convenience to the patient and to the physician.

For purposes of orientation, a clinical study has been organized in twelve cooperating clinics, in which the following three schedules are being used for the treatment of early syphilis: (*a*) Injections 3 times weekly for 4 weeks. (*b*) Injections 3 times weekly for 6 weeks. (*c*) Injections 3 times weekly for 8 weeks. On the last two schedules, some of the patients are being given concomitant weekly injections of bismuth. The results to date with respect to toxicity are encouraging. Further modification may, however, prove desirable in the light of continuing clinical experience, and particularly, in the light of end-results.

Harry Eagle
Ralph B. Hogan

STORAGE OF RADIOACTIVE IODINE IN A METASTASIS FROM THYROID CARCINOMA[1]

A patient with metastatic thyroid carcinoma was studied from the standpoint of storage of radioactive iodine. The carcinoma was of the adenoma malignum type with widespread bone metastases showing colloid follicles, and with no evidence of recurrence of the primary growth removed thirty-five years previously from the thyroid.

A tracer dose of radioactive iodine was given by mouth, and field plots of its distribution were determined by means of a Geiger-Müller counter. The Geiger counts indicated that more of the radioactive substance had been taken up by a metastasis in the right lower femur than by the thyroid gland itself. Other metastases, which, as a therapeutic measure had been irradiated previously with deep x-ray, failed to take up the radioactive iodine in appreciable amount. The material present in the femoral metastasis and in the thyroid gland could not be washed out of these tissues by the administration of 54 mgm of potassium iodide, which indicates that the radioactive iodine was fixed in both these tissues.

The possibility of the use of radioactive iodine as a therapeutic agent was suggested because the meta-

[1] From the Departments of Biochemistry, Medicine, Radiology and Surgery, College of Physicians and Surgeons, Columbia University. This investigation was aided by a grant from the Josiah Macy, Jr. Foundation.

stasis in the femur had fixed such a large proportion of the material. Accordingly a therapeutic dose of 10 millicuries of radioactive iodine, mainly of the 12.6 hour period, was given. The femoral metastasis took up about 30 per cent. and the thyroid gland about 6 per cent. of the total amount administered. Radioautographs of the femoral metastasis were made by placing a film on the patient's thigh and allowing the radiation from the radioactive iodine to darken the film. The position of this metastasis as shown by the Geiger counter and by the radioautographs agreed well with the area of bone destruction shown in the x-ray plates.

About three weeks after the therapeutic dose the metastasis had lost about 85 per cent. of the radioactive iodine, while the thyroid still contained about the same amount as that originally taken up. A tracer dose given a few days after this finding showed prompt uptake by the thyroid gland, but no appreciable uptake by the femoral metastasis. This would suggest that at least the thyroid-like function of the metastasis had been impaired.

The patient is still under observation and a complete report will be made later.

The radioactive iodine was supplied to us through the kindness of Professor E. O. Lawrence, of the University of California, and Professor R. H. Evans, of the Massachusetts Institute of Technology.

ALBERT S. KESTON
ROBERT P. BALL
V. KNEELAND FRANTZ
WALTER W. PALMER

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SENSITIVE CHECK VALVE

BEFORE carrying out electrophoresis or diffusion experiments by methods involving the study of a boundary between solvent and solution, it is necessary to bring a small volume of the colloidal solution under consideration into ionic equilibrium with the solvent, usually a dilute buffered salt solution. Although this can be accomplished by simple stationary dialysis if sufficient time is allowed, it was thought likely that the equilibrium could be attained much more rapidly if some such device as the rocking dialyzer of Kunitz and Simms[1] were used. All that was required was some means of causing the buffer solution to circulate constantly past the dialyzing membrane. As was first pointed out to the author by Dr. D. A. MacInnes, the necessary energy for such circulation can be derived from the rocking motion of the dialyzer. A well-built rocker with a reliable source of power,[2] a small reservoir attached to one end of the table of the rocker, a larger reservoir to hold the bulk of the liquid, some rubber tubing and two check valves to render flow unidirectional constitute all the essential features of the set-up used in our laboratory to obtain the desired circulation. A diagrammatic representation of the assembly is shown in Fig. 1. In order to make the apparatus work, the level of the liquid in the larger reservoir must be intermediate between the upper and lower positions of the smaller reservoir and the check valves must be sufficiently sensitive to be opened and closed by small pressure gradients. A very simple and highly sensitive check valve suitable for such purposes

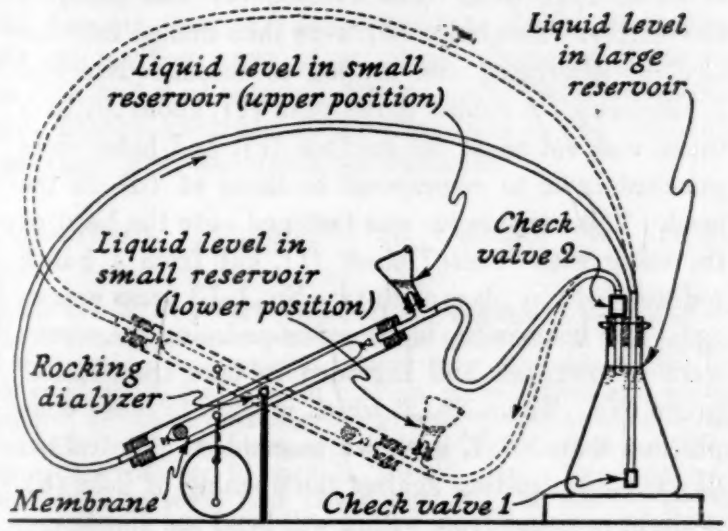

FIG. 1. Diagrammatic representation of assembly for rocking circulating dialysis.

was designed and constructed with the aid of Mr. William Duthie, machinist in our laboratory. Because of the satisfactory service the check valve has given, it was thought desirable to publish a description of it.

The valve consists of nothing more than a very thin sheet of rubber resting against the opening of a hole drilled into a "lucite" rod. A slight pressure tending to cause a liquid to flow out of the hole pushes the rubber film away, but an equally small pressure in the opposite direction causes it to cover the opening securely, preventing the flow of liquid in that direction. As is illustrated in Fig. 2, two modifications of the valve were constructed. The simpler of the two, No. 1, was cut from a 2-inch section of a ¾-inch "lucite" rod. After drilling a 3/16-inch hole (a) through the center of the rod from one end to within 3/16 inch of the opposite end, hereafter designated as the head, a ⅛-inch hole (b) was drilled diagonally

[1] M. Kunitz and H. S. Simms, *Jour. Gen. Physiol.*, 11: 341, 1928.

[2] A 1/80 HP universal motor with a 1: 595 reduction gear manufactured by Bodine Electric Company of Chicago may be used for this purpose.

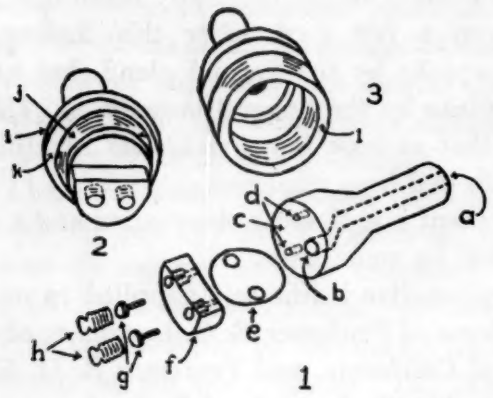

FIG. 2. The check valves. 1. Valve No. 1 shown unassembled. 2. Valve No. 2 shown assembled. 3. Cap for valve No. 2.

from near the edge of the head end so that it connected with (a). The rod was then turned down to the shape indicated in the figure, the head retaining its ¾-inch diameter and the small end being reduced to about 7/16 inch. The surface (c) was polished thoroughly. Two holes (d) were then drilled into the head as illustrated and tapped to accommodate No. 1–72 screws. A rubber diaphragm (e), about .01 inch thick, was cut to fit the surface (c), and holes were punched in it to correspond to those at (d) in the head. This diaphragm was fastened onto the head of the valve with "lucite" block (f), cut from a ¾-inch rod and held in place with two No. 1–72 brass screws (g). The holes in the block accommodating the screws were countersunk and threaded to take the "lucite" plugs (h). Valve No. 2, which is slightly more complicated than No. 1, is shown assembled. The rubber flap is shown resting against the opening of hole (b). A slight pressure from within will bend the diaphragm away, but a slight pressure in the opposite direction will cause the flap to cover the opening securely. Valve No. 1 can be used only on the end of a tube conducting liquid into some sort of reservoir. Valve 2, which is identical in principle, was cut from a 1⅛-inch "lucite" rod and was constructed in such a manner that a cap, 3, could be fitted over it, permitting it to be introduced at any point in a circulation system. A collar (i) was left at the base, and the shoulder (j) was threaded. The cap, 3, which screws onto the valve, 2, was cut from a similar rod. By polishing the surface of the collar (k) and the edge of the cap (l), it was possible to obtain a perfectly tight seal without the use of gaskets, if a little vaseline was applied to the threads before assembling.

Because of the elasticity of the rubber flap, the valve can be used in any position. Pressure differences as low as half a centimeter of water have been found to be sufficient for its operation. Constructed as it is so that only rubber and lucite are exposed, it can be used with most aqueous solutions, excepting concentrated acids and bases, and with those organic liquids which attack neither "lucite" nor rubber. Suitable materials could probably be found for making a similar valve for almost any special purpose.

The advantage of rocking circulating dialysis as here described over stationary dialysis for the equilibration of electrolyte concentrations was demonstrated by dialyzing 15 cc portions of distilled water against 2 liters of 0.2 M NaCl solution for various times using (a) rocking circulating dialysis and (b) stationary dialysis. The latter was accomplished by simply suspending the dialyzing bag near the bottom of the salt solution and allowing it to stand unagitated. Electrolyte concentrations after dialysis were estimated by measuring conductivities. As may be seen in Fig. 3,

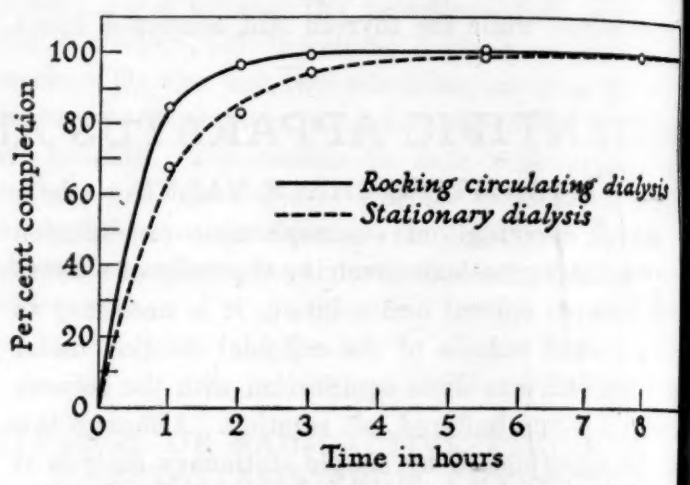

FIG. 3. Comparison of the rates of equilibration by rocking circulating dialysis and by stationary dialysis.

practical equilibrium is reached in about 3 hours by the rocking method but only in something more than 8 hours by the stationary method. In equilibrating viscous materials like protein solutions with electrolyte solutions, the advantages of the rocking method proved to be even more pronounced.

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BOOKS RECEIVED

CARSLAW, H. S. and J. C. JAEGER. *Operational Methods in Applied Mathematics.* Pp. xvi + 264. Oxford. $5.00.

COMPTON, KARL T., ROBERT W. TRULLINGER and VANNEVAR BUSH. *Scientists Face the World of 1942.* Essays. Pp. 80. Rutgers University Press. $1.25.

KLAH, HASTEEN. *Navajo Creation Myth.* Recorded by MARY C. WHEELWRIGHT. Illustrated. Pp. 237. Museum of Navajo Ceremonial Art. $10.00.

MOMENT, GAIRDNER B. *General Biology for Colleges.* Pp. xix + 661. Illustrated. The Century Biological Series. $4.00.

MUELLER-DEHAM, ALBERT and S. MILTON RABSON. *Internal Medicine in Old Age.* Pp. ix + 396. Williams and Wilkins. $5.00.

WENGER, HERMANN LESLIE and ELEANORA SENSE. *First Aid Primer.* Pp. xi + 104. Illustrated. M. Barrow. $1.00.

SCIENCE NEWS

Science Service, Washington, D. C.

COMET OR ASTEROID?

THE fast-moving object in the constellation of Leo, the lion, discovered on March 12 by Dr. Y. Vaeisaelae, of Turku, Finland, has been confirmed and photographed by astronomers at the Lowell Observatory at Flagstaff, Arizona. However, it is not yet known whether the new object is a comet or an asteroid.

A week after its discovery the Lowell observations, made by H. L. Giclas, show that the object is moving about one minute of arc every fifteen minutes, which is rather fast for an asteroid, especially since its apparent path is at right angles to the ecliptic and directly across the sky from the sun. If it is a comet it may have already come nearest the earth, for its motion is slowing down, which may indicate the object is going away. On the other hand, an asteroid (flying mountain) might appear to move this way, if it had an orbit of high inclination to the earth's orbit.

In a letter to Harvard Observatory, clearing-house for astronomical news in the western hemisphere, Dr. V. M. Slipher, director of Lowell Observatory, writes: "Herewith are two positions of the fast moving object, obtained by H. L. Giclas, of our staff. He photographed it both with the 13-inch search telescope and with our 9-inch Schmidt of 22-inch focus. On both negatives the images are not stellar but are somewhat diffused and have the appearance of comet trails."

The positions are: March 18 at 1: 27 A.M. EWT, 11 hours 12 minutes 45 seconds; plus 11 degrees 41 minutes; March 19 at 2: 08 A.M. EWT, 11 hours 15 minutes 3 seconds; plus 13 degrees 24.5 minutes.

This indicates that in the week after its discovery, the object has moved fifteen degrees or one twenty-fourth of the way around the sky. Its motion is just west of north. However, only large telescopes can see it, as it is of the thirteenth magnitude.—CHARLES A. FEDERER, JR.

THE MONTH OF MARCH

ALL over the world, March is the most variable, the most rapidly changing, the most uncertain month of the year. It may be stifling hot or bitter cold; it may be tempestuous or quiet; the sun may shine brightly or it may rain or it may snow. More likely it will be all of these, especially in New England, where samples of all the world's weather and all the year's weather are frequently compacted into this one month of March.

This turbulence of March weather is no accident, according to Professor Charles F. Brooks, director of the Blue Hill Meteorological Observatory of Harvard University at Milton. It has nothing to do with the sun crossing the equator at the vernal equinox except that this is a time of most rapidly changing temperatures, from cold to warm in the northern hemisphere, from warm to cold in the southern hemisphere. The turbulence and the rapid changes here are due to the clash of masses of warm air coming up from the south and of cold air coming down from the north, complicated by "highs" and "lows" crossing from west to east.

Here are some of the average temperatures for March in important cities of the world, furnished by Professor Brooks. The averages are for day and night together, which is about the same as for 10 A.M. local time.

The coldest cities, with temperatures from 17 to 25 degrees Fahrenheit, are Archangel, Moscow, Leningrad and Montreal. Moscow, although 300 miles farther south, is slightly colder than Leningrad, which is near the coast. Hovering a few degrees above the freezing point are Chicago, Boston, Bergen and Berlin. Warm, above 50 degrees, are Rome, Chunking and Los Angeles. Pretty hot, above 68 degrees, are Sydney, Buenos Aires and Dakar. Really hot, averaging over 77 degrees, are Rio de Janeiro, Mandalay and Port Darwin.

Port Darwin is the hottest and rainiest, with an average temperature of 83 degrees and an average rainfall of 10 inches for March.

Stormiest places are the southwestern Pacific and Indian Oceans, right on the routes to Australia and India. This is the monsoon season and hurricanes and tropical rains will abound until some time in April when the southeast trade winds will replace the northwest monsoon.

A NEW BLACKOUT BULB

A BLACKOUT bulb which eliminates need for special drapes and shades, gives ample light to avoid stumbling over furniture, yet can not be seen from the air has been successfully developed and tested by Army engineers at Fort Belvoir, Va., and will probably soon be on the market.

The new bulb is heavily coated with black except for an orange button about the size of a nickel on the bottom. It burns on average house current and will sell for about 25 cents. One bulb per room will provide enough light to permit occupants to see each other plainly, as well as furniture, doors and windows. Only the usual household curtains, drapes or shades are needed when this bulb is the sole source of light. Army pilots and engineers tested the bulb recently in a tiny town in New Jersey (only forty houses). Each home was equipped with the blackout bulbs and shades and curtains left up. When pilots flew over they were unable to see a single ray of light.

The bulbs were developed with the cooperation of the Nela Park Engineering Department of the General Electric Company at Cleveland, Ohio. Army engineers explained that orange was selected as the color for the light-emitting button, since it is near the red end of the spectrum, yet unlike red is not confused with exit lights. Red has been found to be the light least visible from the air.

While the blackout bulb will not permit reading or playing at cards, it is safer and more convenient than no light at all. It can be used to light sections of the house

where there are too many doors or windows for the practical use of blackout drapes. One room of the house can be blacked out completely to permit reading with ordinary light, while the rest of the house can be lighted with the special bulbs.—EDWIN NEFF.

INDUSTRIAL STARCH FROM CULL POTATOES

WEALTH from waste, through a typical exercise of American ingenuity and adaptability, was the story told at the conference by R. E. Gale, of Boise, Idaho, general sales manager of the Idaho Power Company.

Idaho baked potatoes are famous throughout the land; but, Mr. Gales reminded his hearers, selection of the big, smooth, high-quality tubers for this very particular purpose leaves the Idaho potato grower with enormous quantities of cull potatoes on his hands. While some of them are regularly used for stock feed, a discouraging number of carloads are simply wasted, for lack of a satisfactory low-price market. The freight haul to principal population centers is too long.

It was decided, in one Idaho region, to undertake the manufacture of industrial starch out of cull potatoes. The decision was made in early summer; production to start in October had to catch the crop.

Machinery was ordered—and priority and scarcity difficulties promptly encountered. Filling of the orders for certain vital parts of the equipment had to be postponed twice. Things didn't look too good. Then it was learned that in southern Utah, 600 miles away, a beet-sugar factory had closed down and was about to be dismantled. Parts of the machinery were adapted to potato conversion; some structural steel would also be made available. The deal was closed.

Certain necessary speed gears, for centrifugal extractors, were lacking and could not be obtained from regular commercial sources. That universal American source of emergency parts, the automobile junk yard, was put under draft and came through with the necessary gears.

So now the starch mill is a regular, wage-paying part of the potato-producing community.

RUBBER LATEX

How rubber latex that used to be used in making necessary articles of infants' wear now goes into insulation for light-weight communication lines was related before the conference by Dr. M. C. Teague, research chemist of the United States Rubber Company. Dr. Teague told his audience of the scientific juggling which he and his colleagues have been carrying on since the emergency began, to make the country's limited supply of rubber stretch farther.

The latex-insulated telephone wire, samples of which he showed, is produced by a multiple dip process using a special latex compound. It weighs only 30 pounds per mile, as compared with 168 pounds per mile of the older-type wire. The Government has already ordered more than 100,000 miles of the new wire, enough to go four times around the earth.

The list of latex articles used in war is a long one. It includes bullet-proof fuel tanks for airplanes, life rafts, pilot balloons, gas masks, aviator's helmets, blackout paint, sponge cushioning for use in tanks, submarines, gunsight eyepieces, and a thousand other things.

All of this has meant, of course, that civilians have had to get along without some of the things that have meant much to the amenities of modern life, especially the two-way stretch fabrics that have come to be standard parts of bathing suits, foundation garments, shoe tops, and "elastic" generally.

Again the rubber industry has come to the rescue. Dr. Teague told about a new "synthetic" latex made from reclaimed rubber, and exhibited samples of articles made therefrom. Of particular interest, to both military men and civilians, were elastic straps for gas masks, in which neither latex nor raw rubber had any part.

ITEMS

THE Australian News and Information Bureau reports that a new process discovered by an Australian firm will guarantee ample supplies of shark liver oil, rich in vitamins needed by infants. Eighteen months ago when vitamin oil imports from Newfoundland and Great Britain were plentiful, the shark livers were discarded. To-day they are the center of a new industry promising to keep infants healthy and fishermen employed. Fish liver oils are rich in vitamins A and D.

GOVERNMENT efforts to break up a monopoly in production of atabrine, a substitute for quinine in the treatment of malaria, recall the fact that two sulfa drugs were reported last September as possible substitutes for both atabrine and quinine. The two drugs are Promin, which is being tested also as a possible tuberculosis remedy, and sulfadiazine. The pre-war reports on the anti-malaria action of these drugs were somewhat encouraging, but their present status is a military secret. They may have turned out better or worse than the preliminary indications. It is no secret, of course, that a dozen research laboratories in this country are vigorously pushing the search for a substitute for quinine and atabrine. Whether or not we run into a shortage of these two drugs, doctors would like to have a better malaria remedy than either of them.

PLASTIC polaroid goggles which help a pilot's eyes get used to the dark have been perfected for the Navy by the Medical Research Section of the Navy's Bureau of Aeronautics. The goggles are equipped with a special lens which allows very little light to stimulate the portion of the eye's retina used in seeing in the dark. Without light, that part of the retina becomes adapted to the dark almost as quickly as though in complete darkness. The goggles permit the rest of the eye to see. Ordinarily, pilots on night duty either begin their watch "blind" or spend 20 to 30 minutes in a dark room to get used to the dark. By using the new goggles, a pilot may remain in a lighted room until ready to go on duty. The goggles can be made in mass quantities at one sixth the cost of present-type goggles, which require expensive materials. Three types of interchangeable lenses are available; one permits dark adaptation, a second eliminates glare and the third is standard clear lens for wind protection. A shipment of the new goggles has been made to England to permit tests by pilots.